Quality management system for Heidelberg's Bahnstadt Passive House district

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1 Introduction

With the decision to develop the world's largest urban area in which every building, regardless of type, will fulfill the Passive House Standard [Bermich 2011], city officials had to figure out very early on how such projects can be reviewed to confirm that they comply with energy efficiency criteria. Specifically, how are city officials to conduct reviews before construction begins and monitor progress during the construction phase for an entire neighborhood? Such a large-scale construction project brings together a wide range of actors, and not all investors have experience with Passive House – and not all of them voluntarily focus on energy efficiency. The easiest thing for the City of Heidelberg would certainly have been to simply require all buildings in the new district to be certified as Passive Houses. The problem then for builders/investors would have been finding a sufficient number of certifiers with enough capacity. And certification adds a considerable amount to the cost of a project. For certain building categories, there is no experience to base certification criteria on; they would therefore have to be worked up in cooperation with PHI – a time-consuming option. In addition, final certification is generally only granted when the building has been completed.

But then, city officials would have also have to wait until then; the success of the Passive House Standard would solely depend upon the goodwill and expertise of planners, investors, and tradespeople – and on the energy auditor's ability to enforce criteria for certification.

What the City of Heidelberg therefore needed – and eventually found – was a way to set incentives for energy efficiency at the beginning of a construction project and also allow the project to be monitored from the planning to the construction phase.

2 Obligations: their way or the highway?

What do people think when they are forced by law to comply with some standard, such as retrofitting their car so they can get an "expensive" green environmental sticker that allows them to enter downtown Munich, Stuttgart, Berlin, and Heidelberg? A few will be pleased that their car is now more environmentally friendly, but most will certainly see the requirement as a financial burden that takes a lot of time. Furthermore, those whose cars cannot be retrofitted bear the greatest financial burden by having to buy a new vehicle.

Investors in an area like Bahnstadt in Heidelberg probably feel the same. Their purchase contracts for the land specified that any buildings constructed have to comply with the Passive House Standard, which means entering new territory, spending more money, and taking more time. Motivating investors was therefore a crucial part of marketing.

3 Motivation

The marketing strategy praised Bahnstadt as an especially environmentally friendly urban district, and an image of a climate-neutral, ecological neighborhood was expressly created in brochures and at events. In sales negotiations, buyers indicated that the Passive House Standard was a very important reason for them to choose an apartment in Bahnstadt. The recent Heidelberg Study 2012 on climate protection in Heidelberg shows that the local population places great store on protecting the climate. The study found that 60 % of the population is familiar with Bahnstadt's energy concept. [Stadt Heidelberg 2012]

To be certain, investors focused on Bahnstadt because it is so easy to sell or rent apartments and offices in thriving agglomerations, especially downtown areas; what's more, interest rates are very low, and purchasing power in Heidelberg is quite high.

The City of Heidelberg also provided an additional incentive to build Passive Houses: the Rationelle Energieverwendung (Thrifty Energy Consumption) subsidy program. A bonus of 50 €/m² of treated floor area is provided for Passive House apartments, up to a maximum of 5,000 € per unit.

The new district's positive ecological image and the additional financial support certainly helped a lot of investors overcome the initial "obstacle" of energy efficiency and start playing their part.

Nonetheless, there are still a lot of concerns about the Passive House Standard being expensive – and about the requirement to use district heat, which limited planning. The first major step in the quality assurance system was therefore to raise awareness at a very early stage, just as the City of Heidelberg did in implementing its Energy Concept 2010 [Stadt Heidelberg 2010].

4 Bahnstadt's quality assurance system

The City of Heidelberg's quality assurance system is based on the Passive House Institute's criteria for certification as a "quality-assured Passive House."

Step 1: Awareness raising, consulting, and coordination

At a very early stage, the Urban Planning Bureau got the Office of the Environment, Commerce Oversight, and Energy (Environmental Office) involved and began informing investors about all of the energy efficiency targets. This cooperation allowed the first questions to be discussed at a very early point. The focus was repeatedly on the City Council's resolution to require the Passive House Standard – and whether there could be any technical or economic reasons to deviate from the standard, for instance when designing ventilation systems or choosing heat exchanger efficiency. The goal was to get investors to conduct their first PHPP calculation and have their first planning conducted so that subsequent discussions could focus on the initial findings.

The initial planning for the first Passive House project, a very large home improvement store, revealed that the U-values of 0.15 to 0.85 W/(m²K) common for Passive House windows might not be needed, so deviations could be taken into consideration for such large buildings. It was found that the building's airtightness was more important in terms of demand for heating energy than originally planned, so discussions focused on optimization proposals. Blower door tests were also discussed and researched for large halls.

The Passive House criteria could not be strictly applied to the Skylabs building, which houses both offices and laboratories. The large share of lab space increased the requirements for air exchange several-fold; at the same time, only circulation heat exchangers can be used for labs lest the indoor air be contaminated. After intensive discussions, an agreement was reached to have the building envelope comply with Passive House quality, with the ventilation system otherwise assumed to fulfill Passive House criteria for offices.

For the planning of a B&B hotel, a PHPP calculation showed that heat recovery was not required.

Step 2: Construction permit: PHPP certificate required for construction permit

After the first energy concept was coordinated, the second step in the QA system involved linking the urban-planning requirement for the Passive House Standard to the construction permits. Table 1 shows the procedure for permit applications.

A.1	Heating energy demand ≤ 15 kWh/(m²a) The main data are - U-values of opaque building components - windows: U_g / U_f / U_w / g / Ψ pane edge - internal heat sources - treated floor area Plausibility is reviewed; documentation only required for the building permit
A.2	Airtightness Documentation only required for the building permit
A.3	Pressure test air exchange Approach must be plausible; documentation only required during construction
A.4	Primary energy - (PE) ≤ 120 kWh/(m²a) Crucial data include approaches for power and auxiliary power demand and hot water supply. Plausibility is reviewed.
A.5	Thermal bridges at - outdoor air, perimeters, floor slab, window frames, roof The "pencil rule" is used on the construction plans; a pencil traces the 240 mm thick insulation layer around the building envelope. Further documentation is required for the building permit
A.6	Ventilation unit with heat recovery efficiency ≥ 80 % (DIBT minus 12 percentage points), otherwise calculated based on the PHI formula with manufacturer temperature data and no consideration of ventilator output or power-saving drives (specific power consumption 0.45 Wh/m³) At this stage of planning, a brief description, an insulation scheme, and the ventilation system design are expected, and the plausibility of PHPP is reviewed. Further documentation is required for the building permit
A.7	Useful cooling ≤ 10 kWh/(m²a) (*) Plausibility is reviewed; documentation is only needed for the construction permit. Limit values can be exceeded with the consent of the Environmental Office in exceptional cases where there are very great internal heat loads due to usage. It also must be demonstrated that electricity is used efficiently.
A	**Data for the construction application**
A.i	Complete PHPP calculation as an Excel file. Calculations must be updated as planning progresses.
A.ii	Draft plans, digital if possible (PDF)
A.iii	Other documentation on request.

Table 1: Overview of QA system for Bahnstadt building permit process

A PHPP calculation and the latest plans are required for applications for building permits. The processing period of eight weeks on the average begins once all of the documents have been submitted. The PHPP is reviewed to make sure all of the calculations are correct and the assumptions are possible. KliBA, a local climate protection agency, performs the actual reviews of the PHPP calculations. In cases of doubt, the Environmental Office and KliBA may contact planners to clear up matters as soon as possible. The following criteria are taken into account:

If it has no concerns, KliBA presents an expert review with a recommendation for a construction permit on the basis of the energy concept. Whenever anything is unclear or

seems implausible, the building permit can be withheld if the planners cannot solve the problem. Once again, the City tries to reach an agreement with the planners before refusing to provide a permit.

Step 3: Building permit, detailed documentation required

In the next steps of the planning process, various rough estimates have to be turned into specific technical data for calculations in PHPP. Any documentation not provided for the building permit – such as airtightness concepts and calculations of thermal bridges – now has to be presented. In cases of doubt, the Environmental Office and KliBA may contact planners to clear up matters as soon as possible. The documents are reviewed as shown in Table 1 for the building permit. If there are any severe planning errors or if any crucial documentation is not provided, the building permit can be postponed. Once again, the City tries to reach an agreement with the planners before refusing to provide a permit.

Step 4: Contract administration and site observation

After the bidding phase, product documentation and data sheets are available. The construction site is then inspected in coordination with the planners. In the process, critical details that can still be tweaked are reviewed – such as floor slab insulation, window types and connections, external wall insulation, roof insulation, and all connection details relevant for thermal bridges. The thermal transmissivity and thickness of the insulation is then documented, and photographs are taken to document construction progress. Site observation also naturally includes the result of a blower door test. Here, the principle is that the City and KliBA are partners and supporters, not auditors, of the planners. Generally, work with site managers is very cooperative.

Step 5: Updated PHPP after completion

Once construction has finished, all documentation (logs, certificates, etc.) must be completed for submission along with a final PHPP calculation that takes account of all changes. KliBA performs the final inspection of PHPP, which serves as the basis for final approval by construction authorities.

Step 6: Bonuses/penalties

Once the project has been completed, the construction authorities have given their approval, and all documentation has been presented, the bonus from the City's Thrifty Energy Consumption program can be distributed. The first payments amounting to more than 500,000 € for one of the blocks were already distributed in 2012. There is no City funding for commercial buildings; instead, a penalty of around 100 €/m² of gross floor area is contractually agreed to ensure that the Passive House Standard is complied with here as well. Based on experience up to now, quality assurance in Bahnstadt costs around 0.5 €/m² of treated floor space, equivalent to only around one percent of the City's 50 €/m² Passive House bonus.

Step 7: Monitoring

Actual energy consumption in Bahnstadt is to be monitored in cooperation with Heidelberg's municipal utility and PHI as a part of the Passreg project. Total energy consumption will be assessed by block.

5 Summary

The seven steps in Heidelberg's quality assurance program have proven to be very useful in the Bahnstadt zero-emissions district. The further development of Bahnstadt has been ensured by linking requirements from the City Council's Energy Concept Bahnstadt [ebök 2007] to the construction permit procedure; having consulting, informational, and motivational meetings with building owners and planners; and promoting cooperation between EGH, the Environmental Office, KliBA, the Urban Planning Bureau, and construction authorities. The approach can be adopted in other municipalities pursuing similar sustainability goals.

6 References

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