ABSTRACT
The “New House of the Region of Hannover” is the first building in Germany that has been built according to the Standard „EnOB - Energieoptimiertes Bauen“ („Energy optimized building“) as defined by the German Ministry of Economics and Technology within a Public Private Partnership.
This paper – elaborated in a research project on commissioning, operation and monitoring of the building – documents
• the integration of energy efficiency in the PPP competition brief using EBPD strategies,
• the design competition and construction, and
• commissioning and first monitoring results of the building operation.

The combination of a public private partnership for design, construction and financing with ambitious target values for energy efficiency is supposed to demonstrate the possibility of energy efficient buildings at low cost in a very competitive market situation.

Figure 1 shows the front elevation of the winning design with the multifunctional copper-clad conference room next to the entrance.

ENERGY EFFICIENT BUILDINGS AND PUBLIC PRIVATE PARTNERSHIPS (PPP)

The more than 20 demonstration buildings that have been built within the German research program „EnOB - Energieoptimiertes Bauen“ show, that the ambitious target values of a primary energy demand of less than 100 kWhPE/(m²NGFa) ¹ can be achieved technologically with a variety of concepts and technological systems [1].
At the same time, the monitoring showed that the integrated design approach is constantly threatened: not only by cost and time pressure but also by bad building operation and inappropriate user behavior [2]. Without the special attention, motivation and control of the research program the target values in many demonstration buildings might not have been achieved in operation.

In the future, more public buildings in Germany will be built in public private partnerships. The German “PPP-Beschleunigungsgesetz” (German PPP-Acceleration Law) [3] states: “Public private Partnerships play an important role for the modernization of public infrastructure. The financial situation and the deficits in investments in infrastructure require a new collaboration between state and private business. Public private partnerships can provide higher quality at lower cost.”

The PWC guideline “PPP in public building construction” [4] describes Public Private Partnerships as a long term cooperation between state and private business to carry out public services in which the necessary resources (e.g. know-how, capital, personnel) are brought together in a project and where risks are shared appropriately. According to Hochtief, Germany’s largest building construction company, more than 20 billion Euros will be spent on public office buildings, schools and hospitals in public private partnerships until 2009 [5].

It can generally be assumed that in the near future a major part of public investments into the German building stock will be carried out in public private partnerships. Therefore it is of great importance to make sure that a high standard of energy efficiency can be achieved under the special circumstances of a public private partnership. These are with respect to energy efficiency
• a comprehensive and complex contract
• a detailed design at a very early stage of the building process (as part of the contract) and
• a long lasting financial service contract.

In the “New House of the Region of Hannover”, target values of the EnOB-demonstration buildings have been integrated into a PPP project for the first time in

¹ PE: primary energy; NGF: net floor area
Germany. The task of the research project is to show whether the complex technological requirements can be fulfilled and target values be met under these contractual and economic situation in design, construction and operation.

TARGET VALUES IN THE COMPETITION BRIEF
The “New House of the Region of Hannover” provides 300 office workplaces for the public administration on a net floor area of about 7,250 m²NGF. The building includes a 700 m² conference area that can be divided into three sections.

The PPP contract requests a high standard of energy efficiency. All calculations had to be carried out by the design and engineering team according to EnEV 2004 (Mandatory German Energy Efficiency Guideline) [6] and DIN 4108-6:2003-06 (standard calculation method) [7] for heating. For the electricity demand, the LEE Guideline [8] had to be applied using simple “power x hours/year” - calculations. Their combination was used to determine the overall annual primary energy demand of the building. The approach is similar to the DIN 18599 [9] – the calculation method used to implement the EBPD in Germany – that had been introduced during the construction of the building.

The following target values were set in the competition brief:

- The overall demand of primary energy was limited to 100 kWhPE/(m²NGFa) which is about 40-50 % below the mandatory code requirements.
- The primary energy demand for heating was limited to 40 kWhPE/(m²ANa).² (the use of district heating was mandatory)
- The specific air leakage rate according to DIN EN 13829, Type A, was limited to n50 < 1.5 1/h

In addition, specific standards for construction and functional testing procedures had to be fulfilled:

- Windows: Uw <= 1.2 W/(m²K), no fully glazed facades
- Heat recovery systems for all air handling units
- Natural ventilation for offices
- Increased Insulation of internal ducts with low temperatures (30 mm)
- Blower-door-test according to DIN EN 13829, Type A [10]
- Metering of electricity consumption and ventilation rate of all AHUs according to VDI 2079 [11]
- Temperatures in offices below 29°C at all times (simulation of a 2-week summer period according to VDI 2078 [12])

For the competition, the participants had to present the architectural design and a detailed technical concept as well as a guaranteed construction time and annual rates for 20 years of payment. The PPP contract does not include any operation, maintenance or facility management services.

COMPETITION AND CONSTRUCTION
In a first round, 19 teams had applied for participation in the competition. 7 were finally selected for the competition. In the end 6 teams actually handed in an offer for the building. After several rounds of negotiation, a group led by the financial services group CommerzLeasing and Immobilien AG and the construction company Bilfinger Berger was assigned to build the New House of the Region of Hannover according to the design of bünemann + collegen, architects in Hannover.

The contract fixed the overall building cost at about 11 Mio. Euros including 762 €/m²BGF for construction and 282 €/m²BGF for technical installations according to DIN 276 [12]. This value is about 15 to 20 % below the cost for comparable office buildings in Germany [14]. The first target – to stay below comparable building costs – had been achieved.

The building has 6 stories and is L-shaped fitting well into the ensemble of existing buildings. The energy design includes the following specific features:

- Highly insulated building envelope (UWall = 0.23 W/(m²K))
- Highly insulated windows (UWindow = 1.2 W/(m²K))
- 3-layer glazings with an integrated shading system
- 12 ground probes (12 x 70 m) for cooling in summer and pre-heating of supply air of the major AHU (conference area) in winter

The energy design concept is shown for the summer in Figure 2 and winter in Figure 3.

![Figure 2 Energy design concept summer](image)

² AN: usable floor space according to DIN 4108 [7]

3 BGF: Gross floor area
The building is supplied with district heating. It is used for the air handling units in the conference rooms and for convective heating in the offices. The borehole ducts are also used in winter to preheat the supply air for the conference room.

All walls are insulated with 16 cm of mineral wool. The windows have wood-aluminum frames and highly insulated glazings. They are fastened to the walls with air tight joints, see Figure 4.

The offices use simple but effective building systems for energy efficient operation:

- Convective heating and concrete slab cooling
- Thermally active masses, no suspended ceilings
- Manually controlled lighting; motion and lightness sensors are integrated only to turn light off
- Natural ventilation of all offices.

Figure 5 shows the energy design concept of the typical office room.

In summer, the most important target for the Region of Hannover was to keep the temperature in all rooms at a comfortable level. The design team used a dynamic building simulation to prove that the maximum operative room temperature is below 29°C according to VDI 2078 as it was required by the competition brief.

The sun shades are integrated into the 3-layered window glazings. This way they are perfectly wind proof and can be used at all times, see Figure 6.

If nevertheless the temperatures rise, cold water is being pumped through a system of concrete core activation within the ceilings. The water takes upon the heat and takes it to twelve borehole ducts of 70 meters depth each. This cooling system is also used for the AHU of the conference area.

All pumps in dynamic hydraulic circuits are frequency driven with an integrated control.

Work on the building was finished in time after 15 month of construction. It is used since May 2007.
COMMISSIONING AND METERING RESULTS
During the building and commissioning process, several meterings and functional testing procedures have been carried out. The results show that most of the main target values have been fulfilled or even exceeded, see Table 1.

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<thead>
<tr>
<th></th>
<th>Target value</th>
<th>Calculated/ metered value</th>
</tr>
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<tbody>
<tr>
<td>Primary energy demand</td>
<td>100 kWhPE/(m²NGFa)</td>
<td>93 kWhPE/(m²NGFa)</td>
</tr>
<tr>
<td>Primary energy demand heating</td>
<td>40 kWhPE/(m²ANa)</td>
<td>37 kWhPE/(m²ANa)</td>
</tr>
<tr>
<td>Blower door test</td>
<td>1.5 1/h</td>
<td>0.4 1/h</td>
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Table 1 Target values and metering results

During the first weeks, only a few problems occurred in operation concerning the energy design:

- Some of the motion sensors for electric lighting malfunctioned and had to be exchanged
- The pump for the bore hole ducts heated up (reason unclear) and was switched off
- The building management system was not fully usable until mid of July

Due to the mild weather in May and June 2007 the energy design has yet to proof its function under extreme weather conditions.

Conclusion
The integration of a high level of energy efficiency into a public private partnership was successful. The main targets have been achieved:

- The building has been built in time and budget
- The first meterings indicate that the energy consumption will be within the expected range
- It is expected to achieve a good state of operation under all weather conditions within the first year without major adjustments.

The New House of the Region of Hannover shows that it is possible to build an office building with a level of energy efficiency that is 40 – 50 % below the mandatory code requirements without additional cost or significant technological problems.

REFERENCES

\[4\] Including 12.5 kWh/(m²a) for hot water