Federal Institute for Research on Building, Urban Affairs and Spatial Development

within the Federal Office for Building and Regional Planning

Energy, Comfort And Cost Optimization of a Net Zero Energy Building in Berlin

Dr.-Ing. Olaf Boettcher

Commissioner for Energy in Federal Buildings

Federal Institute for Research on Building,Urban Affairs and Spatial Development (BBSR), Germany

WORLD Sustainable Built Environment Conference 2017 HONG KONG

Organisers: CONSTRUCTION INDUSTRY COUNCIL 建造業議會 HKGBC 香港綠色建築議會

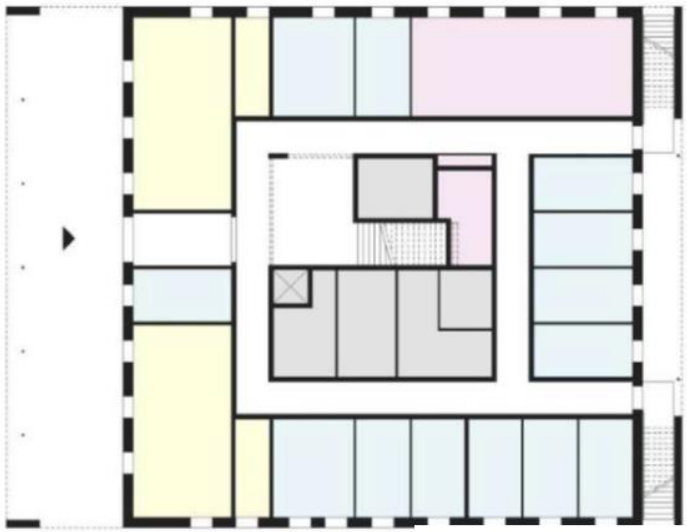
International Co-owners: SBE SERIES iiSBE Sustainable Buildings and Climate Initiative FIDIC Global Alliance for Buildings and Construction

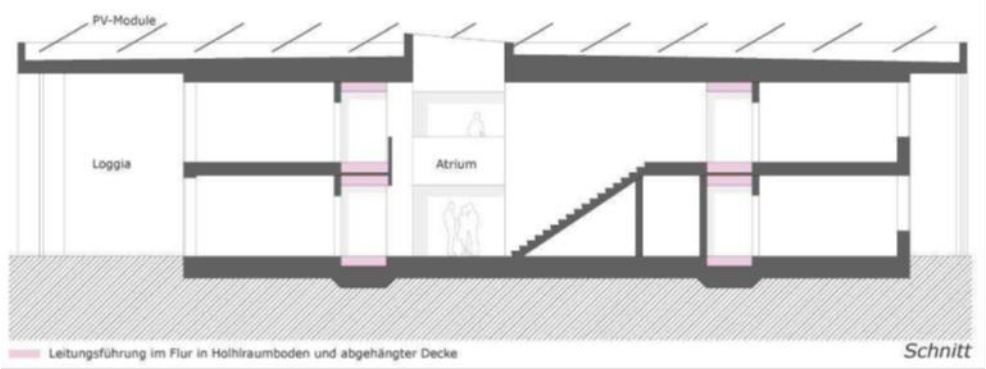
Contents

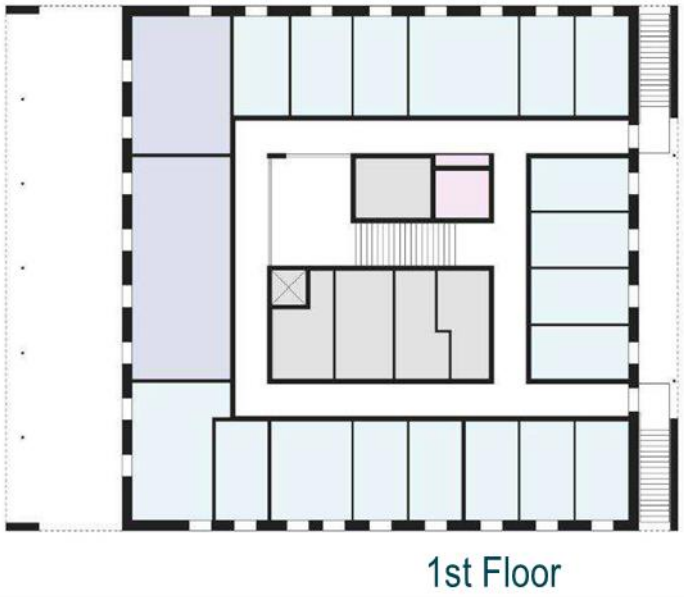
Introduction of the building project
Energy concept
Results of Monitoring
Optimization
Conclusion


Photo by Andreas Meichsner

Project introduction







Graphics by Braun-Kerbl-Löffler Architekten + Ingenieure

UBA – 1st Federal Net Zero Energy Building
- Project introduction

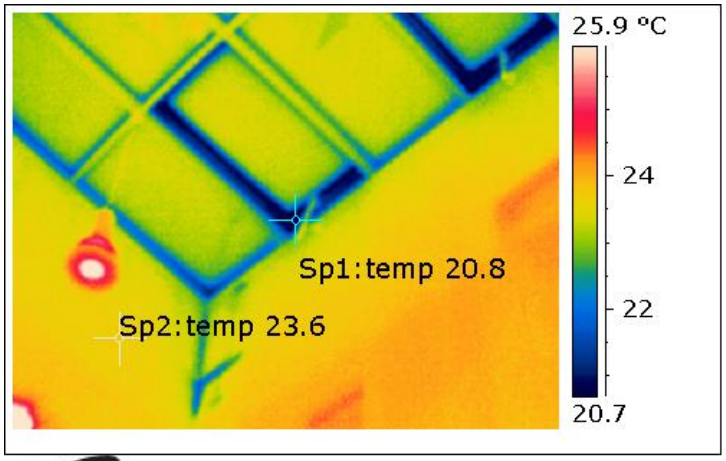
Tasks:

- approx. 30 work places
- green roof (100 % of roof area)
- bicycle-friendly
- high comfort (inside and outside)
- Accessibility
- Sustainability → BNB „Gold“
- Net zero energy building
- Monitoring

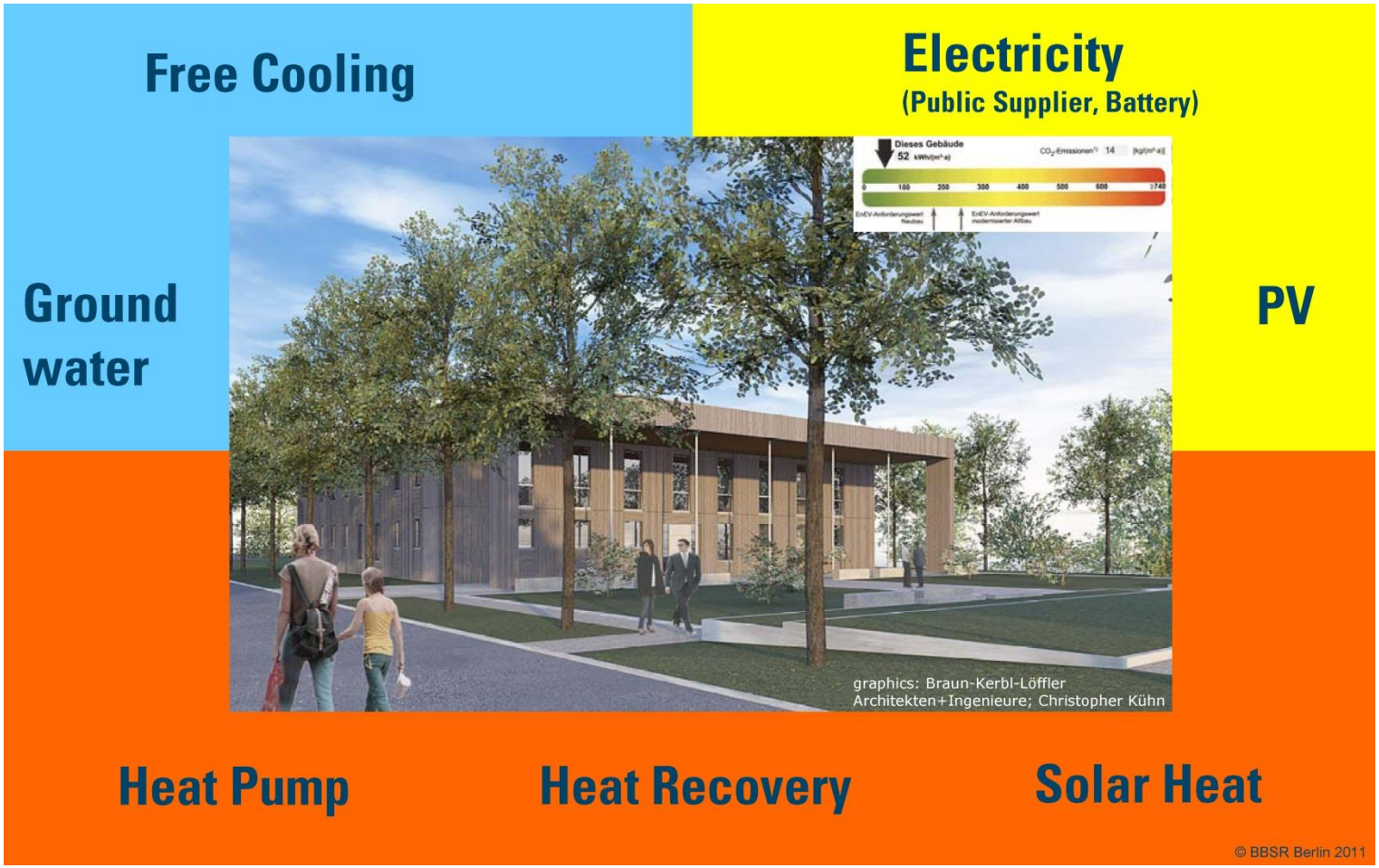
Results:

- areas: 1.076 m² net floor area
- prefabricated timber panels / ferro-concrete bottom slab
- highly insulated building envelope with cellulose
- ring-shaped arrangement of the main types of rooms due to aspects of energy and sustainability
- costs (gross): 5,0 Mio. € (KG 200 – 700)
  - KG 300: 2,0 Mio. €
  - KG 400: 1,5 Mio. €
  - KG 500: 0,5 Mio. €
  - KG 700: 1,0 Mio. €
- planning and construction time: 2009 to 2013 (2 years of construction)
- operation: since 30.08.2013

Energy Concept



UBA – 1st Federal Net Zero Energy Building
- Energy Concept



Building envelope (U-Values):

- External Wall: 0,12 W/(m²K)
- Roof: 0,08 W/(m²K)
- Bottom Slab: 0,10 W/(m²K)
- Windows: 0,80 W/(m²K)

Technical Systems:

- Lighting: electronic ballast; control depending on presence and daylight
- Ventilation: controlled high efficient fans minimal pressure losses in the air system
- Auxiliary Energy: controlled, high efficient pumps
- Office equipment: high energy efficiency

Electricity demand:

ca. 46.000 kWh/a

predicted PV-generation:

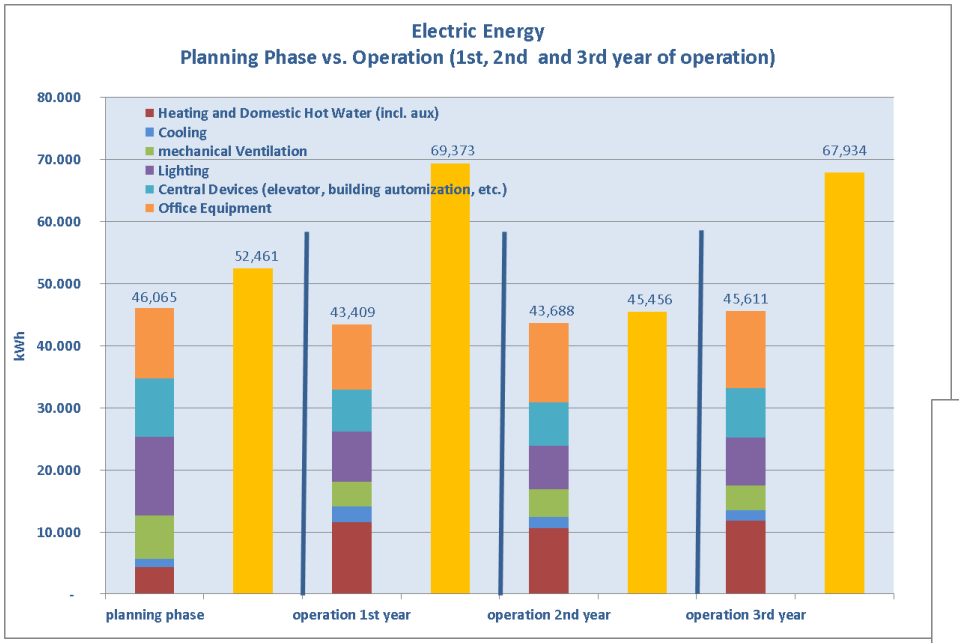
ca. 53.000 kWh/a

Federal Institute for Research on Building, Urban Affairs and Spatial Development
within the Federal Office for Building and Regional Planning

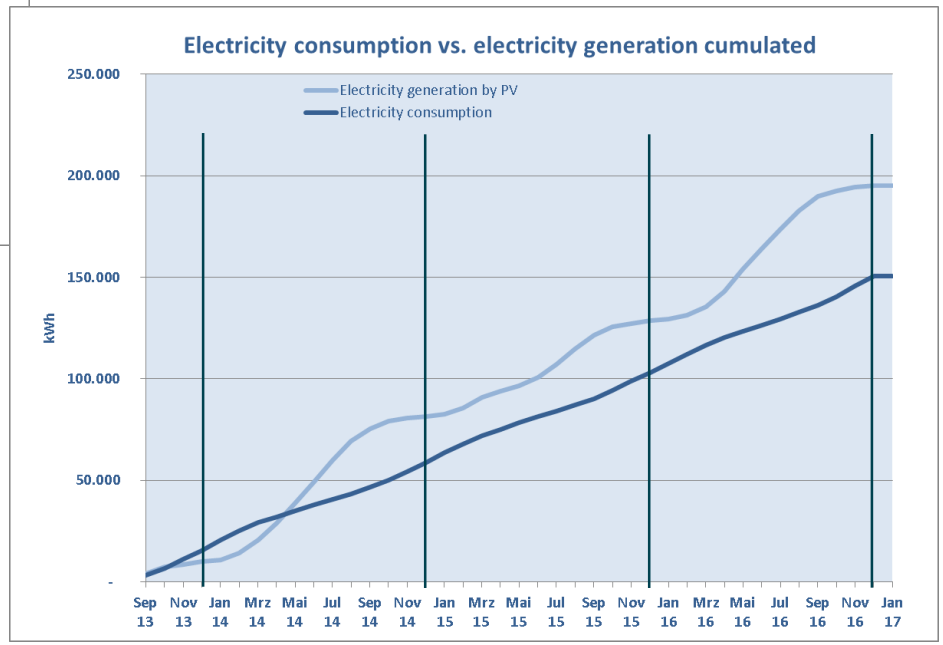
Results of Monitoring

Dr.-Ing. O. Boettcher, BBSR

UBA – 1st Federal Net Zero Energy Building
- Results of Monitoring



The calculated total energy demand (electricity) was approximately equal to the measured one. But there are differences between the calculated and the measured data for the certain technical processes. An optimization of the operation of the technical equipment is still in process.



In all years of operation the generation of electricity is higher than the consumption.

The predicted generation of electricity by PV is much less than the real generation. This is mainly caused by:

- Result of tender action,
- Design errors (software related and others)

UBA – 1st Federal Net Zero Energy Building
- Results of Monitoring

Thermal Comfort

1. W-Lan
2. Presence
3. Thermoanemometer
4. Thermometer and Humidity Sensor
5. Globe-Thermometer
6. CO_2-sensor

Vote:

- Op. Temperature: Category „A“ – good comfort
- Relative Humidity: Category „A“ – good comfort (summertime)
  Category „C“ – limited comfort (wintertime)
- Air velocity: Category „A“ – good comfort

Green roof

October 2013

August 2014

Partners:

UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

Dipartimento di Ingegneria Industriale

UNIVERSITA' DEGLI STUDI DEL SANNIO

Università degli Studi del Sannio

Dipartimento di Ingegneria

Optimization

- Decrease of the energy demand for the operation of the building
- Increase of the self-use of electricity generated by PV
- Options for decreasing the building costs

Photo by Andreas Meichsner

UBA – 1st Federal Net Zero Energy Building
- Results of optimization process

Building model:

- Design of the building model (DesignBuilder and EnergyPlus)
- Transient energy simualtions
- Evaluation of the simulation results in comparison with the designed building (MBE: -1,2 % - +1,9 %, CV(RSME): +8%) and measured data (in progress)

Battery (pre-study):

- Increase of the self use of electricity generated by PV from 27 % to approx. 42 %
- Most economic measures (10 kWh capacity, 16 kW power) led to an increase to 38 % (boundary conditions: 1.000,- €/kW and 1.500,- €/kWh).

Costs:

- The specific costs for architectural works, systems and general equipment are approx. 35 % higher compared to the analogous cost index for highly equipped buildings in Germany.
- Decrease of investment and/or lifecycle costs while achieving the same quality of the building
- Single measures and packages of the single maeasures were investigated.
- The best package in the study results in a decrease of the lifecycle costs by approx. 11 %. The investment costs for that package is 2 % less compared to the base case.
- Further measures have to be investigated.

Conclusions

- The building is well accepted by the users.
- The energetic aims are achieved in general already since the first year of operation.
- The building achieved the highest degree in certification of sustainability regarding BNB.
- Optimization process is running in cooperation with partners (Uni of Naples, Uni of Sannio).

Thank you

BBSR:
E-Mail: olaf.boettcher@bbr.bund.de
Telefon: +49 (0)30 18 401 – 2770

University of Naples Federico II:
E-Mail: fabrizio.ascione@unina.it
Telefon: +39 (0)81 768 – 2292