Energy base, office building of the future

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Abstract

Energy base, started as a research project in 2003 and finished in 2008 is the result of true solar design, and shows how highly energy efficient and highly comfortable an office building can be, when architects and engineers and building simulation consultants work together in an intergral way. Thus it was possible to have 60% glazing on the south façade, highest indoor comfort, outstanding architectural quality at moderate costs and still meet the goal of total energy savings of 80% compared to contemporary Austrian building standard and the goal of using 100% renewable energy.

1 Building origins

In 2003 AIT (Austrian institute of Technology) asked pos architekten to take part in a research project called "sunny research". The goal was to develop a new generation of office buildings with very high comfort and extremely low energy consumption. The research was funded by the Austrian Ministry of Transport, Innovation and Technology. 3 years later, in 2006 we started the planning of a real building to demonstrate our results. Owner is the Austrian business agency, the building was cofounded by BMVIT and EU as a interreg 3a project.

2 Building Features

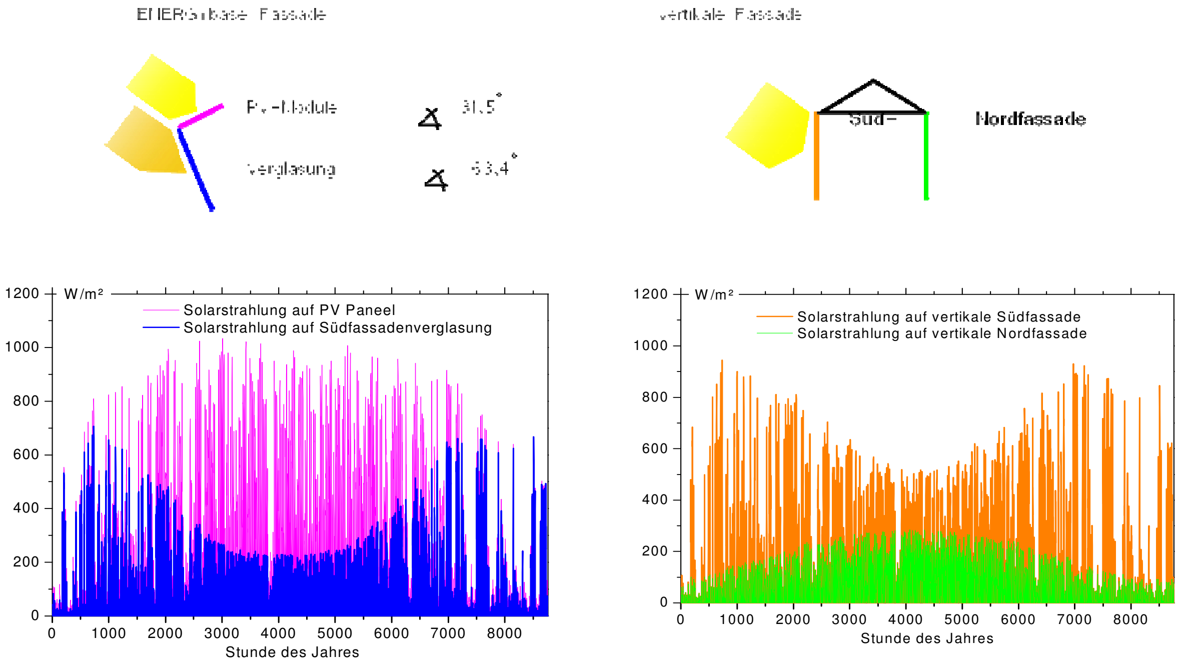
ENERGYbase, a certified passivehouse office building in Vienna with 7.500 m² useful floor area focuses not only on energy efficiency, but equally on users comfort and the use of renewable energy. The occupants of ENERGYbase building are mainly business companies and institutions for research and education in the field of renewable energy.

3 solar and energy efficient architectural concept:

compact volume and solar orientation of the building shape, high ratio of glazing to provide high daylight quality, still matching PH cooling standard.

Folded south façade with maximum daylight, maximum passive and active solar gains, (400 m² PV, 300 m² solar thermal), maximum sun protection in summer through intelligent design. South facade reacts like a north façade in summer.

Due to the shape of the south faced façade the opaque elements follows two functions. Primary active solar energy systems are façade integrated and generate power and heat and secondly overheating by solar radiation is prevented because of an optimal shading effect in summer of the opaque façade elements. According to the passive house concept - which is already applied successfully in residential buildings - the passive use of solar energy in winter time is taken into account and this solar design of the south faced façade reduces the heating demand of ENERGYbase office building and as well the daylight comfort is improved.



comparison of the solar radiation on the glazing and PV panels of energy base (left)and on a normal south/north façade (right).

The special design of the south faced façade increases the amount of solar radiation in the range of 38% in comparision to vertical south faced façade, e.g. active solar components generate much more energy.

3.1 heating and cooling:

All the minimum amount of Heating and cooling is done by ground water via heat pumps in winter and free cooling with heat exchanger in sommer.

3.2 end energy demand:

The end energy demand for heating, cooling, WW, ventilation, lighting, aux. Energy is 26 kWh/m²,a, 5 of those produced by building integrated PV, 21kWh/m²,are taken out of the net (austrian water power)

4 Primary energy, renewable energy

To keep the primary energy demand as low as possible the energy performance of ENERGYbase concentrates on the use of locally available renewable energy sources. First geothermal heat is used by wells water for heating with heat pump and for cooling by free cooling. The energy distribution system of the office building mainly operates by using thermal mass activation, therefore high efficiency can be achieved with the heat pump system, and direct free-cooling is possible. Solar energy is actively used three times in the south faced façade: solar-assisted air-conditioning in summer, heating support in winter and production of electricity all season long by photovoltaics.

5 Users comfort

ecological air humidification by using 500 plants in buffer rooms integrated in the ventilation system (min. 40% rel. humidity in winter)

energy distribution system operates by using thermal mass activation, therefor high indoor comfort by radiant heating and cooling.

Acoustic comfort by well dimendsioned absorbers for room acoustics: carpets, baffles suspended from the ceiling (due to the concrete core activation no suspended ceiling is possible), and absorbing materials behind perforated gypsum board in the walls.

6 Assessment 1: PHPP

The PHPP is an assessment tool which only deals with energy efficiency not with sustainability on the whole. For assessing energy efficiency it is quite a reasonable tool, although it is better designed for housing than for office buildings.

6.1 Internal loads

In the PHPP you are supposed to take 3,5 W/m² as internal loads for office buildings. This is ok for the winter season but for summer it is necessary to take realistic internal loads, which tend to be much higher.

The internal loads of an office building depend very much on how many people are working/m² and what devices they use. In the PHPP you are supposed to take a minimum of 20 m²/person up to 50 m²/pers., and very energy efficient PC devices, whereas in reality you normally have 12m²/person and when the owner lets the building, he has no influence on the efficiency of the PC, printers and so on. So, the internal loads are more than double the ones used in PHPP.

In energy base therefore we did 2 PHPPs. On for winter with internal loads of 3,5 W/m², as is demanded in PHPP, and the second for summer season, where we took realistic internal loads of at least 7,3 W/m². With both heating and cooling demand we match the PH criteria.

6.2 Windows and daylighting:

In energy base we use a large amount of glazing (especially on the folded south façade) with very slim frames. In summer the windows on E,W and north sides are shaded with exterior blinds, the folded south sides shades itself, therefore only needs interior shading against glaring.

By minimizing the frames we can achieve a positive solar gain in the average over all facades. East and west facades have almost equal transmission losses and solar gains, but the large openings to the south (60% of façade) and the smaller openings to the north (30% of façade) provide more solar gains than losses on south and north sides counted together. (even with considering the shadow by neighbouring buildings).

The heating load climbs up to 13,2 W/m², but the daylight conditions are excellent and the cooling demand stays below 15 kWh/m²,a and can be provided very efficiently by ground water. The end energy for cooling is only 1,8 kWh/m²,a.

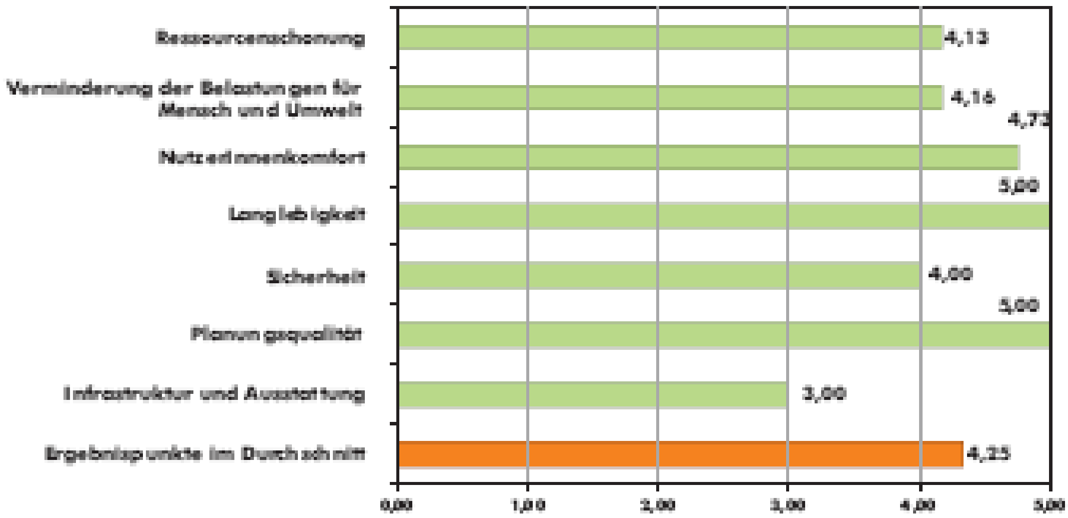
Therefore, acting with good exterior shading, the very large windows are of human and energetic advantage for the building.

7 Assessment 2: TQB (ÖGNB)

Energy base has also been assessed by the austrian sustainablity assessment tools TQB.

In this tool, the sustainability is considered on a much wider range than in the PHPP.

In TQB the building is qualified by 0 to 5 of 5 possible points in several categories. 1:preservation of resources, 2:minimizing the impact of humans and environment, 3: users comfort, 4: durability,5: security, 6: quality of planning, 7: Infrastructure and facilities.



Energy base can achieve excellent results in durability, users comfort and quality of planning (4,75-5 of 5). In the preservation of resources it fails the 5, because it uses new land, and because 25% of the surface left over is a sealed surface. It does not use enough recycled material and the transport management of the construction site was considered only medium.

In minimizing the impact of humans and environment energy base only gets 4,16 points. This is due to a weak traffic reduction because the number of bikeports (energy base has only 60 for 600 users) is not enough. Another part that influences the evaluation of nr.2 is, that the focus of energy base was very much on energy efficiency and comfort and not so much on the ecological impacts of the materials. Several proposals of the architects did not undergo construction because of the costs. The architects f.e. wanted to use slag stare in all concrete slabs (a cement free concrete) and clay plaster on the interior walls. We suggested a special environmentally friendly carpet and wanted to avoid PVC and PUR completely. In this the architects were not followed by the owner, so that we avoid PVC now mostly but not totally.

The worst result energy base is achiving is in infrastructure and facilities. This is due to the location in the far north of Vienna, where there are only a few super markets around, no school, no kindergarten, only 1 restaurant, no doctors, no park, no sports facilities and car sharing opportunities.

8 Conclusion

Energy base can serve as a model for the office builiding of the future even in 2010. It shows that end energy consumption for the whole building can be lowered down to about 20 kWh/m², year (without office devices such as PCs) and that it is possible today–assuming PV also covering the complete roof of the building- that an office building with 5 or 6 storeys can provide all the energy needed on its own building surface, only using south façade and roof.

References

[1] *Total quality building certificate, www.oegnb.at*

[2] Research project energy base, final report: http://www.hausderzukunft.at/publikationen/view.html/id717