THE ENERGY CONCEPT OF THE FEDERAL ENVIRONMENT AGENCY'S OFFICE BUILDING IN DESSAU

Technical innovations for sustainable operation

Umwelt Bundes Amt
For our Environment

THE FIRST IMPERATIVE:

Reducing energy consumption

The new office building of the Federal Environment Agency (Umweltbundesamt, UBA) was erected as a model project for sustainable building with very ambitious goals. In order to significantly reduce the consumption of fossil energy sources, the energy demand of the building to be constructed had to be as low as possible to allow sustainable operation. The prime prerequisite for minimizing the energy demand is for the building to have a form as compact as possible as well as a highly heat-insulated shell.

Generated solar energy and daylight were to be used in the best possible way, helping to further reduce the demand. Taking advantage of natural processes was to be preferred over technical solutions - ‘low tech’ rather than ‘high tech’. As a pioneer project sending out a signal to other office-building developers, it does without mechanical cooling (air-conditioning) to create an acceptable indoor climate and, in particular, indoor comfort during the hot season.

VERIFIABLE GOALS

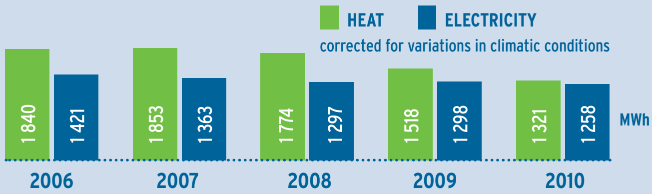
Energy requirement between that of a low-energy and a passive building (Passivhaus)

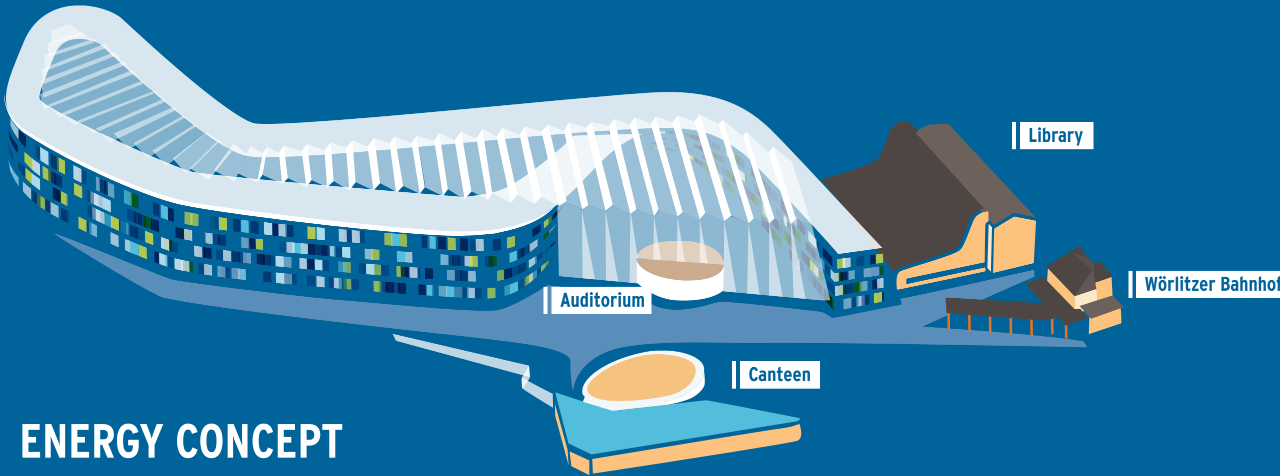
Targets for heat and electricity requirements

The annual heat energy requirement was to be limited to ≤ 38 kWh/m2 $_{htNFA}$a (heated net floor area per annum), which, at the time planning took place, is almost 50 % less than the maximum allowed by the Thermal Insulation Ordinance of 1997, and about 30 % less than the maximum allowed by the Energy Saving Ordinance of 2005. The dominant factor for the total energy requirement of modern office buildings is the electricity requirement, and not the heating requirement, so a target of 25 – 30 kWh/m^2 $_{ht\ NFA}$a was set for the electricity requirement. Total final energy needs were not to exceed 62 kWh/m^2 $_{htNFA}$a (heat energy and electricity requirement). In parallel, a CO_2 weighted primary energy demand of not more than 100 kWh/m^2 $_{htNFA}$a was set as a target. In actual operation, annual consumption of heat energy in 2010 was 49.7 kWh/m^2 $_{htNFA}$a and electricity consumption in that year was 48.3 kWh/m^2 $_{htNFA}$a, with a total final-energy consumption of 98.0 kWh/m^2 $_{htNFA}$a.

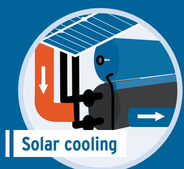
Coverage from renewables

The political decision that the energy supply should come, in principle, from regional power stations, which had previously been modernized with federal funds, restricted the possibilities for action. Therefore, a target of 15% of the total energy requirement was set for the share of renewable energy generated on site. The planning included a PV system, solar collectors for cooling, and a geothermal heat exchanger. An originally envisaged small cogeneration plant run on landfill gas from the local landfill was not realized as this was an investment which had already been planned in advance and could not therefore be counted towards the building project. As a result, coverage from renewables currently has a share of 10%.

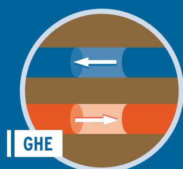




ENERGY CONCEPT



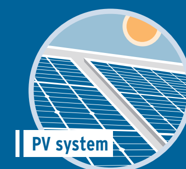
Solar heat cools the server room, the auditorium, a.o.



The geothermal heat exchanger preconditions fresh air on a renewable basis, cooling it in summer and heating it in winter.

When no natural ventilation can take place, the ventilation regime ensures a two-fold air change per hour.

Roof-top free cooling generates cold water for conditioning the air to the server room, the auditorium, etc.



Solar electricity powers some of the PCs.

MONITORING

The goal was to meet energy targets at lowest-possible costs while taking environmental as well as hygiene and health concerns into account. This meant, for example, that building materials were required to be recyclable and attention was paid to keeping the overall carbon footprint including transport-related CO_2 emissions as small as possible. Use of aluminium was therefore largely avoided, for example. In addition, all mass-produced building materials used were analyzed for their 'embodied energy'.

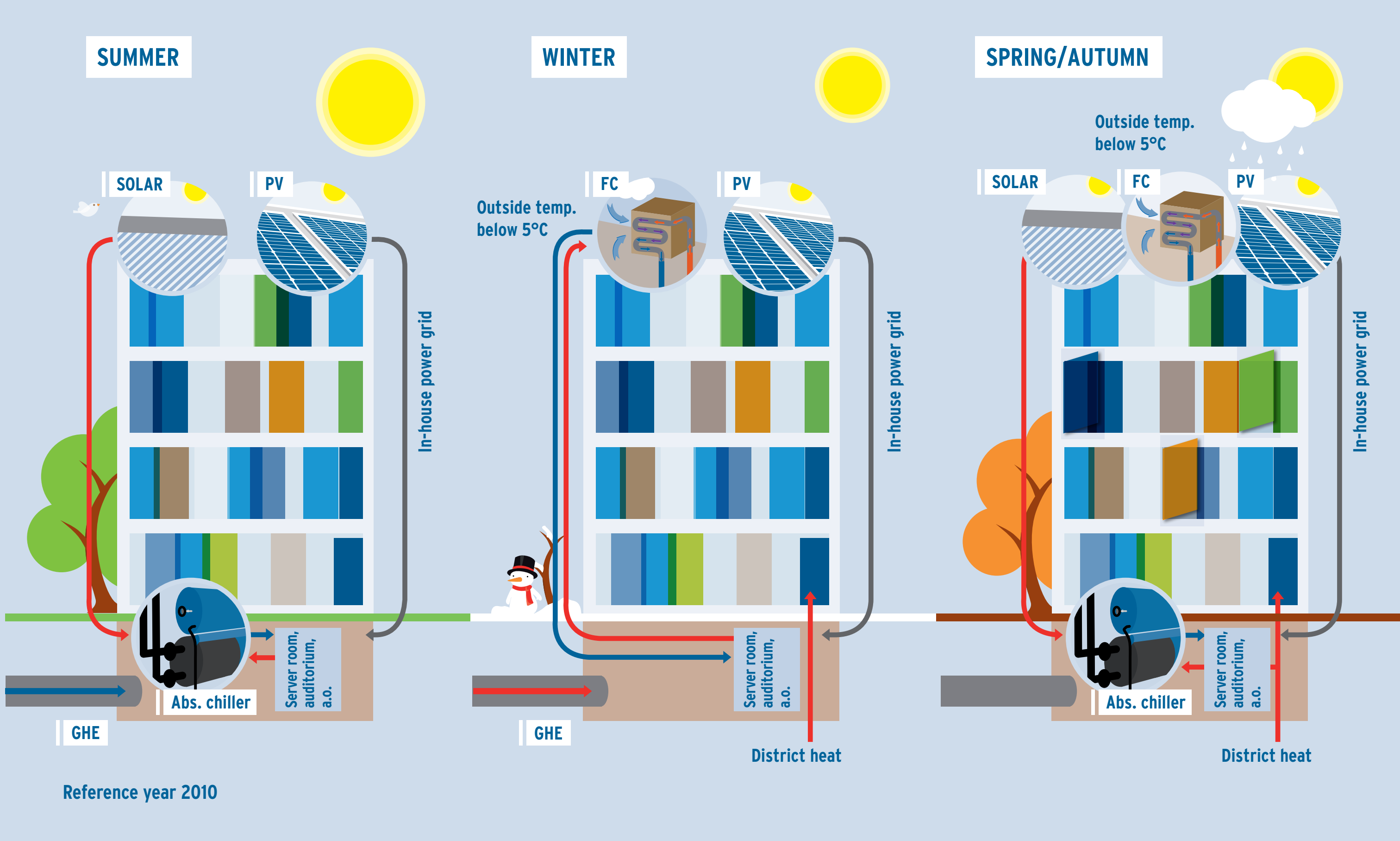
A concept for operational monitoring was developed as early as the planning phase in order to monitor technical and economic performance after completion of the building and see whether and to what extent the targets are being met and, secondly, to be able to optimize operations on a sound technical basis.

LIGHTING

The office areas are lit by ceiling lights, each having a plug-in module comprising an integrated daylight sensor, a presence detector registering even the smallest movements and an infra-red interface. The average level of illumination in the offices is 300 lx/m^2; 500 lx is provided at the workplaces themselves. Agency staff can adjust the level of illumination as needed by means of remote control. There are no light switches. In the corridors, recessed downlights are installed in the ceilings. Here too, as well as in the library, 'intelligent' presence sensors make it possible to provide illumination as and when needed. Corridors partly lit by daylight are fitted additionally with daylight sensors.

BUILDING AUTOMATION FOR OPTIMIZED OPERATION

To allow a largely automatic and economical operation of the technical building services, a primary building management system (BMS) was installed. This combines 37,000 data points by means of an automation system using DDC (direct digital control) to enable simplified operation, centralized monitoring and optimization of the technical building services.


SUMMER
SOLAR
PV
In-house power grid
Abs. chiller
Server room, auditorium, a.o.
GHE
WINTER
FC
PV
Outside temp. below 5°C
In-house power grid
Server room, auditorium, a.o.
GHE
District heat
SPRING/AUTUMN
Outside temp. below 5°C
SOLAR
FC
PV
In-house power grid
Abs. chiller
Server room, auditorium, a.o.
District heat
Reference year 2010

TECHNICAL INNOVATIONS

Focus on energy generation from renewable sources

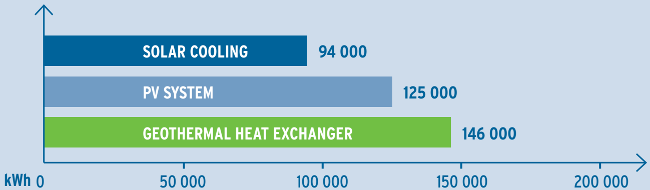
The key elements of the technical building services and the building's energy supply are:

Solar cooling

Solar heat collectors with a total surface area of 216 m^2 are installed on the roof of the building. Since an office building does not normally have a great need for hot water, but does have a considerable demand for cooling, the solar heat collectors are used for cold production (solar power) – a type of use which is still rare in Germany. This solar energy system supplies hot water to an adsorption chiller, which has an output of 48 kW at about 75 °C. When the solar radiation intensity is low – at night or when it is cloudy – the adsorption chiller is operated with heat from the district heating system.

Geothermal heat exchanger

The geothermal heat exchanger consists of a horizontal system of pipes approximately 5 kilometers in length, laid at depths of up to 3.70 m and divided into four fields around the building. Air is drawn in via intake structures and passed through this system – consisting of pipes made of reinforced concrete 1.50 m in diameter and grid pipes 30 cm in diameter. This warms the air in winter and cools it in summer. After passage through the system, the air is filtered and ducted to the offices.



Reference year 2010
corrected for variations in climatic conditions

PV system

The third element of the energy concept is a photovoltaic system with a capacity of 100 kWpeak and a collector area of 655 m^2, which is situated on the glazed shed roof and the flat roof of the building. Its electricity output is about 125 000 kWH per year. The renewable energy generated by this system is sufficient to supply about 330 offices with electricity (IT and lighting).

Ventilation

The air from the geothermal heat exchanger is fed to air handling units. Except in winter, when the air is reheated, there is no conventional air-conditioning for office space. A two-fold air change per hour guarantees sufficient air quality in the offices.

When outside temperatures are between 15 °C and 23 °C, the offices are ventilated naturally, i.e. by Agency staff opening the windows in their offices. A simple strip of paper in front of the air vent in each office indicates whether or not the ventilation system is in operation. Night-time cooling during the summer months is an additional element in this regime: In outward-facing offices, centrally controlled panels in the exterior façade are opened during the summer between 10 p.m. and 6 a.m. to utilize the cool evening and night air. For this purpose the offices' concrete ceilings were left exposed to allow them to act as storage mass.

This system is complemented by centralized exhaust ventilation via the corridors and a heat recovery system which recovers 74 % of the heat contained in the exhaust air.

Free cooling

Free cooling is the technique which uses the least amount of energy for cold production, which is why it is used as a priority. However, this happens only when the outside temperature falls below 5 °C. Hot water generated by consumers (server room, auditorium) is fed to the roof, where it is cooled in a register by passing air. During periods when the outside temperature is above 5 °C, the system is used to cool down water vapor for the absorption chiller, whereby the vapor liquefies at 30 °C. When the free-cooling regime is active in winter during very sunny periods, the heat generated is fed to the heating system.

The Forum (entrance lobby) and exhibitions shown in the Forum are open to visitors during the building's opening hours:

Mon to Fri	6:00 am to 10:00 pm
Sat	6:00 am to 4:00 pm
Sun/hols	8:30 am to 4:00 pm

The visitors centre (information material) and the library in the Forum are open

Mon to Wed	9:00 am to 3:30 pm
Thu	9:00 am to 5:00 pm
Fri	9:00 am to 2:00 pm

Visitors who would like to learn more about the architectural and ecological design of the new building and visit the Atrium can join a guided tour. For more information about this, ask at our visitors centre or visit our website (www.uba.de).

Photo credit: Jan Bitter

Umwelt Bundes Amt

For our Environment

Umweltbundesamt

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