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The New Energy Conservation Code in the Federal Republic of Germany

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Synopsis

With effect from January 1st, 1995 the amended Heat Transfer Barrier Act („Wärmeschutzverordnung“) was introduced in the Federal Republic of Germany, replacing the 1982 version. This decree is binding on all houses to be built so that they reach the low energy standard. Former decrees envisaged mainly the reduction of the transmission heat loss while the amended version takes into account all other relevant aspects such as internal and solar heat gains as well as ventilation heat losses, and includes them into an energy balance procedure. In this way the new Heat Transfer Barrier Act does not lay down certain construction types or heating techniques, but focuses on the annual heat energy demand. With this energy conservation code the German Government aims at a 30 per cent reduction of the heat energy demand of new houses

1. The Heat Transfer Barrier Act

1.1 The Legal Background

The legal background of the Heat Transfer Barrier Act, HTBA, ("Wärmeschutzverordnung") was fixed in 1976 when the „Energieeinsparungsgesetz“ (EnEG), an energy conservation code, was passed. With the first Heat Transfer Barrier Act in 1977 the energy conservation code was put into practice. The necessity of the reinforced conservation of energy together with the development of modern construction techniques then lead to the amendment of the Heat Transfer Barrier Act in 1982 as well as to its introduction into planning and building laws and regulations in 1984.
The latest HTBA came into force on January 1st, 1995 after four years of difficult negotiations: Within the framework of its strategy to reduce the energy related emissions of the greenhouse gas CO_2, the government of the Federal Republic of Germany decided in November 1990 to amend both the Heat Transfer Barrier Act and the Heating Systems Act. Further impetus gave the report of the commission of enquiry „Precautions for the Protection of the Global Atmosphere“ („Vorsorge zum Schutz der Erdatmosphäre“) which was adopted by the German Parliament in September 1991. When the reflections on the part of the European partners regarding any hindrance of the common market were dispelled the cabinet decided the final version in July 1994.
On the occasion of the hearing in the German Ministry of Trade and Commerce the Fachinstitut Gebäude-Klima e. V. commented on the important topics of ventilation and heat recovery.

1.2 Area of Application of the '95 Heat Transfer Barrier Act

The main area of application of the '95 HTBA are buildings to be constructed. The latters are divided into three sections or types, depending on their use and indoor temperature level. Accordingly, they have to fulfill graded requirement profiles. Furthermore, the HTBA contains rules and requirements as for constructional changes like extension or heightening of existing buildings. Figure 1 gives an overview of the area of application of the '95 HTBA.

In the following areas, HTBA-requirements have to be met:

- Buildings to be constructed with normal indoor temperatures such as dwellings, office and administration buildings, schools etc.
- Buildings to be constructed with indoor temperatures between 12 and 19 °C such as industrial buildings
- Extension or heightening of existing buildings

- Change of individual heat transferring components of existing buildings (replacement, renewing, installation)
- Particularly relevant individual components such as slats for shutters, surface heating, ventilation systems etc.

2. The main changes of the HTBA

2.1 Increased requirements: With the help of the new HTBA the heat energy requirements and the pollutant emission of new buildings will be reduced by 30 per cent compared to the previous standard. In order to achieve these values, the heat requirement of new buildings follows the standard of low energy buildings, which is 54 to 100 kWh/m^2a. Comparing calculations show that the annual oil consumption can be decreased to 6-12 l/m^2 and the gas consumption to 6-12 m^3. Before, the standard consumption of oil driven heating systems amounted to more than 20 l/m^2a.

2.2 New proof procedure: While in the previous calculations only the heat loss through the building envelope (transmission heat loss) was considered, the new HTBA lays down an energy balance procedure. The u-value (k-value) calculation is only valid for (normally) heated small dwellings, i. e. buildings with up to two complete floors and not more than three accomodation units. Here, however, the requirements regarding the heat transfer are tightened compared to the 1982 HTBA. In all cases one of the two possible proofs of the heat transfer barrier have to be furnished. Figure 2 shows the area of application of the proof procedures for buildings to be constructed as well as for the extension of existing buildings.

Fig. 2: Area of application of the proof procedures according to the '95 HTBA

proof of the annual heat energy demand (heat balance procedure)		simplified proof for small dwellings (so called building component procedure)
binding	dwellings to be built with more than two storeys or more than three accomodation units	
optional	dwellings to be built with not more than two storeys and not more than three accomodation units	optional
binding	buildings to be constructed with normal indoor temperatures such as office and administration buildings, schools, hospitals, old people's homes, restaurants etc.	
optional	constructional extension or heightening of existing buildings by at least one heated room or more than 10 m^2 of joined heatable and useable surface	optional

The new calculation procedure is based on a heat balance of the entire heated building, i. e. not only the transmission heat loss, but the ventilation heat loss as well as solar and internal heat gains are considered also. The transmission heat loss informs about how much heat is transferred through the building envelope (external building components). The ventilation heat loss represents the amount of heat lost due to the exchange of warm indoor air against cold outdoor air. Solar heat gains indicate the amount of heat resulting from solar radiation into the building while internal heat gains result from several factors occurring inside such as occupancy, quantity of computers and other electronic devices used, lighting, etc. The calculated value now represents an energy parameter of the considered building on which the calculation of the annual heat energy demand is based.

2.3 Bonus arrangement for energy saving ventilation systems: The installation of ventilation systems can help reduce ventilation heat losses. Reduction factors according to the ventilation system that is built in may be used now for calculating the ventilation heat loss. The reduction factor of supply/exhaust systems is 0,95, the factor for systems with heat recovery and systems with heat recovery and heat pump is 0,80.
In order to prevent the operation of ventilation systems from being more energy consuming than energy saving, limiting values for the energy use of each system type have been fixed. As the annual heat energy demand of each building has been fixed, too, the reduction of ventilation heat losses thanks to a ventilation system allows the constructional heat insulation to be reduced. In order to limit constructional ventilation heat losses, the requirements in view of building airtightness were tightened, too.

2.4 The heat demand certificate for new buildings represents another important innovation of the '95 HTBA. It informs authorities, builders, tenants and buyers clearly about the energy relevant features of a building. This heat demand certificate contains a written synopsis of the calculated results of the heat transfer barrier proof. The builder or the owner of a building has to show the certificate to potential buyers oder tenants of his building. Normally the architect or the construction engineer issues the certificate and delivers it to the builder. The heat demand certificate is always issued for the entire building and not only for one accomodation unit. It informs about the determined annual heat energy demand, but not about the real energy demand of a building per year.

The proof procedure represents the core of the amended Heat Transfer Barrier Act. In the following, it is explained more precisely therefore:

3. Course of the proof procedure

At first, the ratio that the heat transferring parts of the building envelope A bears to the enclosed building volume V is calculated for a certain building plan (the same procedure as before).
Secondly, the upper limiting value of the annual heat energy demand is evaluated. This is done by the calculation of the A/V-ratio and ranges between 17,3 and 32 kWh per m^3 of the heated building volume and per year.
Only with buildings with a clear height equal to or smaller than 2,6 m, the maximum values can refer to the effective area as well. In this way they cover a range from 54 to 100 kWh/m^2 useable floor space and year. According to the '95 HTBA „useable floor space" means 0,32 times the heated building volume V. The staircase, basement and loft do not belong to the heated building volume V.

Fig. 3: Maximum values of the annual heat energy demand which is based on the heated building volume or on the useable floor space A_N in dependance on the ratio A/V.

Ratio A/V	Maximum annual heat energy demand	
	referring to V Q'_H 1) according to clause 1.6.6	referring to A_N Q''_H 2) according to clause 1.6.7
in m^{-1}	in kWh/m^3a	in kWh/m^2a
1	2	3
< 0,2	17,3	54,0
0,3	19,0	59,4
0,4	20,7	64,8
0,5	22,5	70,2
0,6	24,2	75,6
0,7	25,9	81,1
0,8	27,7	86,5
0,9	29,4	91,9
1,0	31,1	97,3
< 1,05	32,0	100,0

Intermediate values are to be determined according to the following equation:

1) $Q'_H = 13{,}82 + 17{,}32\ (A/V)$ in kWh/m^3a

2) $Q''_H = Q'_H/0{,}32$ in kWh/m^2a

Dwellings with an A/V ratio of $0{,}72\ m^2/m^3$ and a headway of equal to or smaller than 2,60 m show a maximum annual heat energy demand of 82 kWh per m^2 useable floor space and year.

Following now is the calculation of the annual heat energy demand of the entire building and after this it has to be checked whether the calculated result exceeds the upper limiting value of the heat energy demand or not. If yes, constructional changes have to be integrated into the plans until the recalculated results meet the required values.

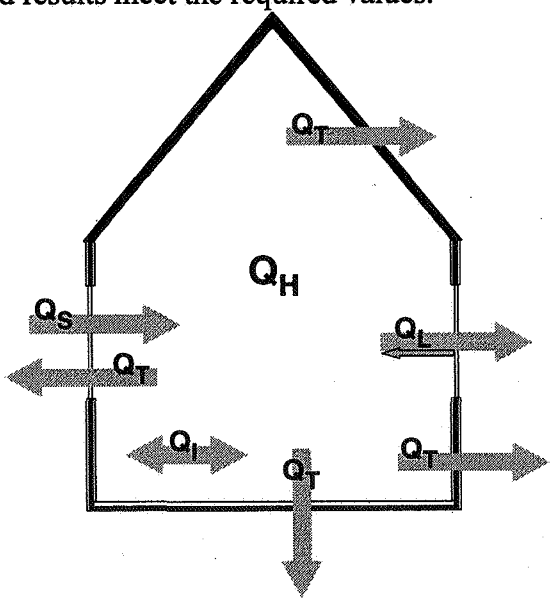


Fig. 4: Annual heat energy demand

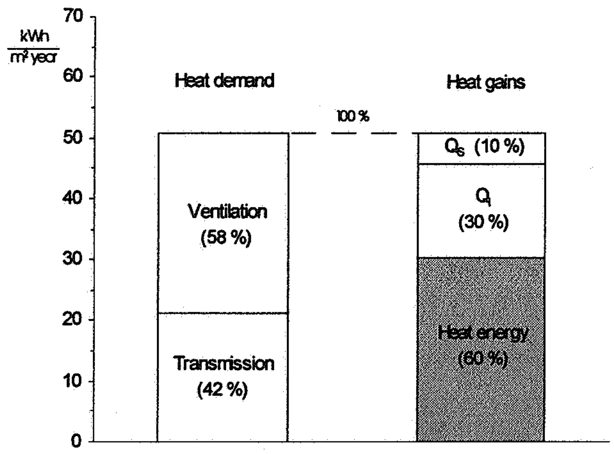
The annual heat energy demand Q_H of a building is composed of

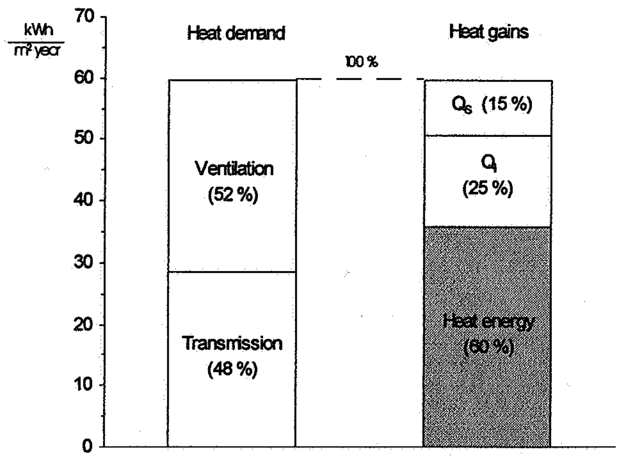
- the transmission heat demand Q_T
- the ventilation heat demand Q_L
- the useable internal heat gain Q_I caused by the heat emission of persons and technical devices
- useable solar heat gains Q_S.

It is to be calculated for the entire building according to the following equation:

$$Q_H = 0.9\,(Q_T + Q_L) - (Q_I + Q_S)$$

The time spans of lowered indoor temperatures are taken into account with factor 0.9. Each single demand and all heat gains are to be determined according to the HTBA procedures. With the ventilation heat demand it has to be distinguished whether the building is ventilated through window opening or through a mechanical supply/exhaust system with or without heat recovery. As for solar heat gains, the solar radiation is evaluated according to the orientation and the angle of inclination of the window or the french window considered. Before starting the calculations therefore the orientation and the angles of inclination of all windows and french windows have to be determined.





Apartment building with six accomodation units

Useable floor space:	544 m^2
„A/V" ratio	0,49 m^2/m^3
Upper limiting value of the annual heat energy demand	69,7 kWh/m^2 year (100 %)
Annual heat energy demand:	50,6 kWh/m^2 year (73 %)

Semi-detached corner house

Useable floor space:	123 m^2
„A/V" ratio	0,72 m^2/m^3
Upper limiting value of the annual heat energy demand	82,2 kWh/m^2 year (100 %)
Annual heat energy demand:	59,7 kWh/m^2 year (73 %)

Fig. 5: Graphic representation of two calculation examples

Figure 5 shows the calculated results of the annual heat energy demand of an apartment building with six accomodation units and of a semi-detached corner house. The annual heat energy demand of each house remains under the upper limiting value by 27 per cent thanks to the building components and building constructions used. It is characteristic of both buildings that the useable internal and solar heat gains almost meet the respective transmission heat demand and that the ventilation heat demand corresponds to the scale of the annual heat energy demand, respectively. These results are applicable to other dwellings without heat recovery from exhaust air. It is clearly shown that the considerable influence of the ventilation heat demand on the annual heat energy demand is getting ever more important the better the building envelope is thermally insulated.

'95 Heat Transfer Barrier Act/Calculated results of the annual heat energy demand of two kinds of dwellings

4. Conclusion

The examples clearly show that the '95 Heat Transfer Barrier Act can be an effective instrument to reduce the pollutant emissions of new buildings. However, each regulation is only as effective as the possibility of controlling it. The annual heat energy demand simply represents an approximate value of the resulting heat energy demand. This is due on the one hand to the simplicity of the algorithm. Besides, the execution of the construction work as well as the heating and ventilating habits of the occupants can have a considerable influence on the heat energy demand. The problem of controlling the real annual energy consumption can not be solved therefore.
The current Heat Transfer Barrier Act is to be reamended in 1999. It is desirable that the amendment will not only bring along a further intensification of the constructional heat insulation and of the annual heat energy demand, but all energy relevant factors should become more severely integrated than before. In this way the Heat Transfer Barrier Act could be transferred definitely into an energy conservation code.

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