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Largest study in Europe into buildings' heating consumption published

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The turnaround in energy policy will be decided in the nation's living rooms

by Oliver Mertens

More energy is wasted in heat-insulated buildings than in uninsulated ones. Absolute energy consumption continues to drop as the energy-saving quality of buildings improves, but the effect of users and their tendency to waste energy is on the increase. That is the result of Germany's largest study of energy efficiency in buildings, carried out by the renowned Prof. Dr. Clemens Felsmann. His conclusion: The better the energy-saving condition of the building shell, the less the inhabitants worry about their heating usage. For this reason, the scientist is in favour of consumption-based billing of heating costs even in very well-insulated buildings. The study also shows the large potential to reduce CO_2 emissions via heating billing. »»

Felsmann presented the largest German study so far on "the effects of billing in reference to buildings' energy-saving qualities". The professor for building energy technology and heat supply lectures at the Institute of Power Engineering at the Technical University of Dresden. The Institute enjoys a very good reputation and often carries out work for the German government. The Arbeitsgemeinschaft Heiz- und Wasserkostenverteilung e.V. (Cooperative for Heat and Water Costs Distribution) provided Felsmann with anonymised measured data from 3.3 million homes. There are a total of 18 million homes in multi-occupancy buildings in Germany.

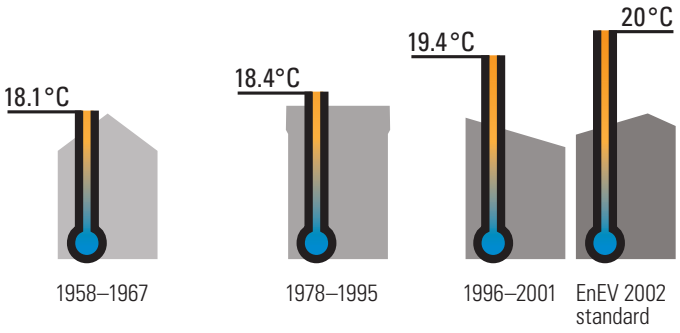
LOWEST CO_2 ABATEMENT COSTS

The study confirms the large potential to reduce CO_2 emissions via heating billing. Since billing was made mandatory in 1981, approximately 350 million tonnes of CO_2 have been saved. Most energy efficiency measures taken to abate CO_2 result in costs. Consumption-based billing, on the other hand, results in savings of almost 200 euros per tonne of CO_2 abated. "No other remotely comparable measure (such as additional insulation) has such low abatement costs as consumption-based billing," says Felsmann. According to his calculations, heating bills are more effective than energy-saving bulbs and are even comparable with modernisation of all unmodernised single-family or two-family buildings.

USERS IN OLDER BUILDINGS MUCH MORE ENERGY-CONSCIOUS

The analysis shows that the measured room temperature in two thirds of all homes surveyed in multi-occupancy houses is considerably lower than the theoretical norm of 20 °C. Half of all values recorded were even under 19 °C. Users in older buildings are therefore much more energy-conscious than previously thought, and their behaviour also has a greater influence on overall consumption than we used to assume. The measured energy consumption of older buildings is, on average, much less than the requirements calculated in accordance with the EnEV. This means that the potential savings of energy-related measures applied to building shells and appliance technology have been overestimated.

The Felsmann study proves that average room temperatures increase significantly as the building's energy-saving quality increases. Homes that were built between 1958 and 1967 have, on average, a room temperature of 18.1 °C. Buildings from between 1978 and 1995 are kept at only marginally higher temperatures. Buildings built between 1996 and 2001, however, are kept considerably warmer at 19.4 °C. Buildings built to the EnEV 2002 standard are kept warmer again, at about 20 °C. In buildings built according to the current EnEV, room temperatures are higher yet again, on average.



Average room temperatures acc. to year of building construction

ENERGY CONSUMPTION FOR HOT WATER UNDERESTIMATED

Another result of the study is the fact that the condition of the building has no effect on the energy requirements for heating water. Its relative share of the overall heat consumption increases, however, as the building's energy-saving qualities improve. For new buildings, this share is above 30 %. Felsmann used the comprehensive data to calculate an average energy consumption of 26 kilowatt-hours per square metre and year (kWh/(m² a)) for water heating. This consumption figure is more than double the energy requirement of 12.5 kWh/(m² a) assumed in DIN V 18599 Part 10. In an older building built before 1977, approximately 17 % of the heating »»

consumption is due to water heating. In buildings built in accordance with EnEV 2002, it is as much as 28 %. In individual cases, the share of consumption due to water heating can rise to 50 %. For this reason, Felsmann recommends that consumption-based heating and hot water cost distribution be extended to new buildings and energy-optimised older buildings in order to encourage users to save energy.

ENERGY CERTIFICATE SIGNIFICANTLY SUPERIOR

Because the calculation basis (DIN V 18599) uses different underlying assumptions, the calculated energy consumption is not reached in new buildings. It turned out, however, that potential savings in older buildings could only be forecast with any confidence if the actual consumption situation was investigated for each individual case. The effects of the energy-related regulations of the EnEV were being overestimated for new buildings as well as older ones. The scientist claims that user behaviour is the main reason for this. In new buildings with low energy requirements, in particular, users consume more heat than calculated due to their heating and ventilation habits.

CONCLUSION

User behaviour is a decisive factor. Only if users know how much energy they consume can they rethink their energy-usage habits. And only if they rethink their habits will they change their behaviour. According to Felsmann, this may result in rooms being heated less or only partially, in more requirements-driven ventilation and in the use of less hot water. «

ABSTRACT OF THE FELSMANN STUDY

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Effects of consumption-based billing with reference to buildings' energy-saving qualities

Clemens Felsmann, Juliane Schmidt

The energy consumption of residential buildings is largely determined by their energy requirements for space heating and domestic hot water. With regard to quantifying possible energy-saving effects, the main focus lies on the impact of user behaviour on the energy consumption in addition to the building's physical attributes (energy demand) and the operating conditions of appliances (energy efficiency). Room heating requirements, for example, are largely determined by the building's design and can – assuming standard usage patterns and weather conditions – be worked out with established calculation methods (e.g. DIN V 18599). However, actual building operation often leads to wide variations in consumption figures, largely due to user behaviour. Surveys have also shown that buildings with the same design can show wide differences in their energy consumption if they have similar uses but are operated differently. Users thus have a strong and verifiable effect on consumption both in space heating and domestic hot water generation.

Experience has shown that user-specific heating cost distribution is a very effective measure to influence user behaviour and to reduce heating consumption and CO_2 emissions.

Increasing energy-saving qualities of building shells and appliance technology makes this effect even stronger. Experience has shown that user-specific heating cost distribution is a very effective measure to influence user behaviour and to reduce heating consumption and CO_2 emissions. User behaviour can be influenced largely by consumption-dependent billing of heating costs and can be seen, for example, in reduced or »

needs-driven heating (lower room temperatures or heating of only parts of the home), in changes to ventilation and in reduced hot water usage. One decisive factor is whether and to what extent a user can be encouraged to change his or her operating and usage habits – i.e. to use energy in a more conscious way – through consumption-based heating bills. As part of the current investigations, user behaviour was extrapolated from real energy consumption figures. The data was also used to analyse the effects of this user behaviour on the energy consumption in buildings whose energy-saving design attributes were known.

Anonymised energy consumption data recorded by different metering service providers from over 320,000 buildings with more than 3.3 million flats or approximately 283 million square metres of living space.

To this end, anonymised energy consumption data recorded by different metering service providers from over 320,000 buildings with more than 3.3 million flats or approximately 283 million square metres of living space. This quantity of data material has so far never been equalled in Germany. The data collected were evaluated using energy performance certificates and processed for further use. This was done separately according to property size or number of units and year of construction or energy-saving quality of the building shell. Buildings were also divided into those heated with district heating and those heated with a boiler.

The investigation method chosen for a systematic investigation of the connection between consumption-based billing and energy-saving building qualities as well as a possible extrapolation of the results was a building simulation. Building models were created using a simulation programme for thermal building and appliance simulation. A similar distinction was made according to property size and building age class when creating the models. Four different building sizes were created, each with five different energy standards. The models were validated by comparison with the consumption data collected. They were then used to map user behaviour in behaviour with reference to the energy-saving qualities of a building's shell.

The simulations allow us to conclude that improved building heat insulation and the resulting drop in energy requirements make users tend more towards waste. This can be seen in the fact that, in energy-saving buildings with several residential units, even small deviations in the behaviour of individual users (e.g. choosing higher room temperatures) has a significant influence on consumption spread. From this we can conclude that consumption-based billing for heating will continue to play an important role in the future, not just in ensuring that billing is fair, but also in realising the energy-saving potential that was envisaged by constructing energy-saving buildings. The relatively low investment costs of setting up consumption-based billing are also helpful.

Experiences with consumption-based heating cost distribution published in several studies allow us to extrapolate average energy consumption savings of 20% as a result of the introduction and implementation of Germany's Heating Cost Ordinance. This study shows that even higher savings can be achieved, even in new buildings. On this basis, it has been calculated that the abated CO_2 emissions since the introduction of the Heating Cost Ordinance in 1981 until 2012 were up to 348 million tons of CO_2. The savings generated by consumption-based billing could abate an additional 95 million tons of CO_2 by 2020. The CO_2 abatement costs of consumption-based billing, for example, were 195 EUR / t of CO_2 in 2010. They thus represent financial yields and can be considered extremely beneficial when compared with other energy-saving measures in the property sector. ‹

The entire study can be ordered from E.V.V.E. (info@evve.com).

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