

## **Summary of the Research Project „Data Base of the Building Stock – Data Survey of the State and the Trends of Energy Saving Measures in the German Residential Building Stock“<sup>1</sup>**

Dr. N. Diefenbach, Dr. H. Cischinsky, M. Rodenfels (Institut Wohnen und Umwelt<sup>2</sup>, Darmstadt)

Dr. K.-D. Clausnitzer (Bremer Energie Institut<sup>3</sup>)

22.12.2010

### **Project Aims**

The project aimed at filling information gaps about the German residential building sector, especially with regard to the realised energy saving measures. Those information gaps had been analysed in a predecessor study [Diefenbach et al. 2007]. They concerned the current state of the building stock as well as the modernisation trends. An improvement of the data was intended especially for the evaluation of progress in climate protection and for the making of predictions and scenario analysis.

The project was carried out by Institut Wohnen und Umwelt (Darmstadt) in cooperation with Bremer Energie Institut. It was funded by “Forschungsinitiative Zukunft Bau“ of the Bundesamt für Bauwesen und Raumordnung<sup>4</sup>, by KfW Bankengruppe and by Hessisches Ministerium für Umwelt, Energie, Landwirtschaft und Verbraucherschutz<sup>5</sup>

### **Project Implementation**

#### Survey of house owners carried out by chimney sweepers

During the research project a representative survey of house owners was carried out to get the necessary data basis. It was presumed that the house owners – especially in comparison with the tenants - possess the most reliable information about their buildings and supply systems. Also employees of housing companies or administrators of dwelling owners’ associations were interviewed as representatives of the house owners.

The survey was carried out by chimney sweepers. This approach was chosen because of the following aspects: Germany is completely and without overlaps divided into chimney sweepers’ districts. Even buildings which do not use fuels but electric or district heating systems are in principle assigned to a chimney sweepers’ district. Moreover the district’s master chimney sweeper has access to the building owners in his district, who are his customers. The “Bundesverband des Schornsteinfegerhandwerks – Zentralinnungsverband (ZIV) <sup>6</sup>“ –

---

<sup>1</sup> Datenbasis Gebäudebestand – Datenerhebung zur energetischen Qualität und zu den Modernisierungstrends im deutschen Wohngebäudebestand

<sup>2</sup> Institute for Housing and Environment

<sup>3</sup> Bremen Energy Institute

<sup>4</sup> Federal Office for Building and Regional Planning

<sup>5</sup> Hessian Ministry of Environment, Energy, Agriculture and Consumer Protection

<sup>6</sup> German national association of chimney sweepers

was integrated into the project from the beginning and also the associations of the German Federal States and regional associations of chimney sweepers<sup>7</sup> were informed. They supported the project substantially.

### Contents of the survey

The questionnaire was relatively extensive, containing 16 pages. As far as possible in such kind of survey, the building properties which are relevant for energy efficiency were considered in detail. For example regarding thermal protection of building elements the thickness of insulation and the area fraction of insulation were considered. In the case of heat supply questions about additional heat generators (like solar systems or wood stoves) were included. Besides, the questionnaire took account of general building data (e.g. erection year, number of apartments, type of building property), of the construction method (e.g. type of wall, type of roof), and of other refurbishment measures (e.g. new roofing, plaster renovation). The financing of energy saving measures, subsidies, and plans for future energy saving modernisation were also included. At the end, independent of the energy saving aspects, the question of barrier-free construction and living was considered as an additional topic with growing relevance.

### Two-stage sampling

The integration of chimney sweepers in the survey resulted in a two-stage sampling design with chimney sweepers' districts on the first and building addresses (within the participating districts) at the second stage. In the exceptional case with more than one building per address (e. g. an area of farm buildings) there was an additional stage: The chimney sweeper had to choose one among the concerned buildings according to a given random process.

Random sampling was carried out at each level to make possible the application of statistical theory, especially the calculation of confidence intervals and standard errors.

### Stratification criteria

There was a stratified sampling of chimney sweepers' districts on the first stage and of building addresses on the second stage, i. e. the respective sampling units were divided into subsets.

On the first stage the Federal State of the building was chosen as a stratification criteria. Thus a regional balance of the sample of chimney sweepers' districts was ensured from the beginning.

On the second stage, at the sampling of building addresses within a district, different building types were considered. This was done to get into the survey a sufficient number of buildings of two special subsets, multi family houses and new buildings, and to make possible a separate analysis of those two building types:

- Multi-family houses (here: residential buildings with three or more apartments) are an important sector of the building stock. Whereas only 17 % of the total number of residential buildings is concerned, more than 53 % of the apartments are placed in multi-family houses.

---

<sup>7</sup> Schornsteinfeger-Innungen

- Also the set of new buildings (here: residential buildings erected since 2005) is quite small compared to the total building stock. But in the long term the numbers of new buildings sum up so that the question of the state and development of the new buildings' energy performance is very important for attaining the energy saving and climate protection targets.

Against that background a disproportionally high number of those building types were selected. When carrying out projections at the total building stock the different sampling probabilities of the buildings which result from the special characteristics of the sampling procedure are balanced by the assigned weighting factors.

### Nonresponse Correction

Among the selected buildings an overall response rate of 53 % was achieved. This result confirms the initial expectation, that the chimney sweepers would achieve a high return of questionnaires. To make possible an identification of biases by nonresponse, the chimney sweepers were asked to fill in a short, only two-page "chimney sweeper's questionnaire" for each of the delivered building addresses, regardless of the building owner's participation in the survey. This questionnaire included some basic data, inter alia the building type (single or multi-family building), the type of building property (e. g. single person, dwelling owners' association or housing company) and the information whether the chimney sweeper already knew the building owner or not. In the last case mostly buildings with electric or district heating systems were concerned.

Actually the response rates were slightly different depending on the type of building and property and the chimney sweeper's knowledge of the building owner. These differences are corrected by weighting factors during survey analysis.

### Adaptation to the national statistics of construction activity<sup>8</sup>

A comparison of the projected sample results with the statistics of construction activity shows a good consistency. Remaining differences were corrected by a redressment analysis which considered the building type (single- or multi-family house), rough geographic criteria (building location in the new German federal states or in the northern or southern part of the old federal states) and the erection year (building erection until 2004 or since 2005).

## **Results and Perspectives**

After carrying out all plausibility checks and adaptation analysis the „data base of the building stock" now includes 7510 evaluable data sets, among those 7364 residential buildings and 146 non-residential buildings with dwellings. 415 master chimney sweepers took part in the survey, representing about 5,4 % of the German chimney sweepers' districts. There are results from 241 urban and rural districts, that is from about 56 % of the German districts.

Thus the data base can serve as a basis for detailed analysis of the state and the modernisation trends of the German residential building stock with regard to energy saving measures. Extensive analysis was already carried out during the research project considering various

---

<sup>8</sup> Bautätigkeitsstatistik

criteria, for example building types (single- or multi-family buildings), geographic aspects (e. g. old/new federal states), building property types and construction types (e. g. wall types, historical monuments). The results draw a differentiated picture of the situation concerning thermal protection and heat supply systems. Depending on the observer's perspective different results appear in the point of interest, so that it is almost not possible to give a short summary. Here – as an example for a question of general meaning – the progress in the field of thermal protection is discussed against the background of the long-term climate protection targets.

Looking at the old residential buildings erected until 1978 (circa until the first German thermal protection ordinance<sup>9</sup>) it turns out that roughly speaking the modernisation progress of thermal protection measures amounts to 25 to 30 %. This is a statistical average value which was calculated in a simplified way from all buildings within the sample to which thermal protection modernisation of the building envelope had been applied. The complete or partly insulation of walls, roofs or upper floor ceilings, ground floors or cellar ceilings and the installation of thermal protection glazing were considered according to their approximate contribution to saving energy for space heating. On the other hand and roughly speaking the thermal protection of 70 % to 75 % of the old buildings' envelope area has not yet been improved.

The calculation of the annual modernisation rate of buildings erected until 1978 – in a similar rough way, basing on the thermal protection carried out from 2005 to 2008 and taking the mean of all building elements – leads to a value of about 1,1 %/a. That means that on the statistical average of the time period 2005 - 2008 an improvement of the thermal protection was carried out at only little more than 1 % per annum of the more than 30 year old residential building stock. If this rate continued it would take 65 to 70 years, i.e. at least until 2075, to attain the – only hypothetical – complete modernisation of the old building stock.

If one assumes that an improvement of insulation will also be necessary at the residential buildings erected after 1978 and if one calculates against that background the modernisation rate of thermal protection of the total residential building stock, one will attain an average value of only little more than 0,8 %/a for the period 2005 – 2008. Thus related to the total building stock with buildings of all ages the modernisation rate of thermal protection is still much lower and the implementation period would be accordingly longer.

In the light of the target to reduce the CO<sub>2</sub>-emissions in the industrial countries by 80 % until 2050, which was already established by the Enquete Commissions on Climate Protection of the 11. German Bundestag [Enquete 1990], it becomes evident that a substantial increase of the thermal protection modernisation rates can still be looked upon as an essential challenge of climate protection policies for the building sector.

Detailed information about possible future development to attain the climate protection targets in the building sector could be given by scenario analyses. The available data base of the building stock can serve as a basis for this purpose because it delivers detailed information of the current situation of the residential building stock and by this it lays a basis for detailed analysis, for example regarding different situations and implementation rates at the single building elements, possible restrictions like protection of historical monuments, the consideration of heating and hot water systems or the development of the new buildings' sector.

---

<sup>9</sup> Wärmeschutzverordnung

Given the large variety of information that is included in the 7.510 data sets, it is obvious that not all questions of interest could be considered in the final report of the research project. For that reason IWU will make it possible for others to carry out scientific analysis with the data base.

- |                          |   |
|--------------------------|---|
| [Diefenbach et al. 2007] | Diefenbach, N. / Loga, T. / Cischinsky, H. / Clausnitzer, K.-D. / Vilz, A. (2007): Grundlagen für die Entwicklung von Klimaschutzmaßnahmen im Gebäudebestand – Grundlagen über die bautechnische Struktur und den Ist-Zustand des Gebäudebestandes in Deutschland, BBR-Online Publikatio Nr. 22/2007. |
| [Enquete 1990]           | Enquete-Kommission „Vorsorge zum Schutz der Erdatmosphäre“ des 11. Deutschen Bundestages (3. Bericht, 1990): Schutz der Erde, Bonn.   |