

Development of the energy consumption for heating and hot water in single-family houses in Germany

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The purpose of the study is to give guaranteed insights into the real level and the previous trend of the development of energy consumption for space heating and hot water in the past for one-family houses in Germany.

With the help of these insights

1. resilient reference values for energy passes for existing buildings could be named based on the recorded energy consumption
2. effects of those political instruments triggering an increase of energy efficiency and market activities could be validated
3. the baseline (previous trend in the development of energy consumption) could be ascertained.

The baseline is among others important for

- a potential transfer of the instrument “emissions trade” to the household sector starting in 2013
- joint implementation projects attended to the building sector hosted in Germany (simplified: emission reductions matching the baseline cannot be charged)
- activities of energy suppliers within the implementation of the energy service guideline in Germany.

The detailed aims of the study consisted of

1. the determination of the previous final energy consumption of heating and hot water for at least 5,000 one-family houses for a long period,
2. the cause determination of final energy consumption trends.
3. an investigation determining if spotted consumption reductions are related to administrative regulations of the federal government or a state, information instruments and financial instruments

The methodology consisted basically of the evaluation of energy consumption data as well as conducting and evaluating a survey based on factors which could influence the energy consumption.

Evaluation methodology related to the level and chronological development of energy consumption:

Fortunately 25,000 anonymised data records could be analysed. These data are from the period 1997 to 2006. They arised from EWE AG and affect customers supplying their one-family houses with gas and energy in the Weser-Ems area in Northwest Germany. These data are the results of measurements with calibrated counters, so that high accuracy is available.

Only those data records have been entered into the consumption values which were available for the same customer for the years 1997 to 2006. Therefore, all ownership transfers of one-family houses are not included. All data were converted for a calendar year by EWE on the basis of gas supplier standard systematics.

All EWE data were checked for plausibility. One-family houses with implausible consumption were excluded. The remaining data yet hold the following insecurities:

- Conversion of consumption data for a settlement period into consumption data for a calendar year is generalized.
- It is unclear how customers use natural gas, for instance for space heating only or as well for water heating. As it is neither known if natural gas is used nor how much energy is utilized for water heating, a weather related adjustment of the consumption values following VDI 3807 sheet 1 is not reliable.
- There is ambiguity about possible additional or exclusive use of the building for industrial or free-lance work
- There is no information about additional usage of other energy sources (e.g. wood)

Since there are insecurities for methodologies of data collection and accessories (delimited storage, irregular delivery periods, reliable information), the obtained results are inaccurate but still - within the limits of boundary conditions - best possible results ("there is no other way to do it").

Evaluation methodology of the influencing factor of energy consumption: It has been searched for factors affecting the development of energy consumption. Theoretical factors were collected and discussed, and 5 groups of households in a field study were interviewed telephonically. These households (n=689) are a subset of approx. 25,000 households/buildings, for which the development of consumption could be reconstructed. 4 groups with variable reductions of energy consumption from 1997 – 2006 were considered. Additionally a control group, which showed no significant changes in consumption, was interviewed. For differentiation mathematical aspects were used.

The following 5 groups were distinguished:

1. group: control group: consumption does not change more than 5%
2. group: "slowly-reducing consumers" (max. 10 % reduction within 10 years)
3. group: "saver \geq 15% - 24,9 %
4. group: "saver \geq 25 % - 34,9 %
5. group: "saver \geq 35 %

Results

The rate of energy consumption shows that the methodology elected is very usable. Due to financial-organisational reasons only consumption values of an energy supplier were only analysed for a certain region. But there are no objections to use this methodology for other regions and other time series. However, data can be contemplated only for 10 years due to data protection regulations (the duty to preserve records lasts for 10 years and an additional storage of individual customer data is not permitted).

A (non weather-related adjusted) decrease of consumption from averagely 27,428 kWh in 1997 to 22,256 kWh in 2006 was recognised (the information affects the caloric value H_i , the actual calendar year as well as the consumption value median of the actual calendar year). This results in a decrease of natural gas consumption for one-family houses of approx. 19 % from the year 1997 to 2006. Figure 1 in sub-chapter 3.1 shows the consumption trend versus time. Only those one-family houses are affected, the owners of which were identical from 1997 to 2006. It might be possible that due to change of ownership and consequential modernisation a higher decrease of energy consumption would be noticed.

Interviews for the evaluation of energy consumption influencing factors yielded that 89 % of the interviewees use gas for heating and water heating. It is unknown if this applies also to the approx. 25,000 consumption data cases.

There is no information about the living space for the named 25,000 data records available. Specific consumption data (kWh/(m² * a)) cannot be generated readily. Therefore also the living space was requested in the interview on the evaluation of energy consumption influencing factors. Thereupon the living space averages (median) 140 m². Assuming that this is also the living space of the 25,000 consumption data cases, the results are specific consumption data of approx. 196 kWh/(m² * a) in 1997 and 159 kWh/(m² * a) in 2006.

In total there is a significant decrease of energy consumption in the last 10 years in the range of one-family dwellings.

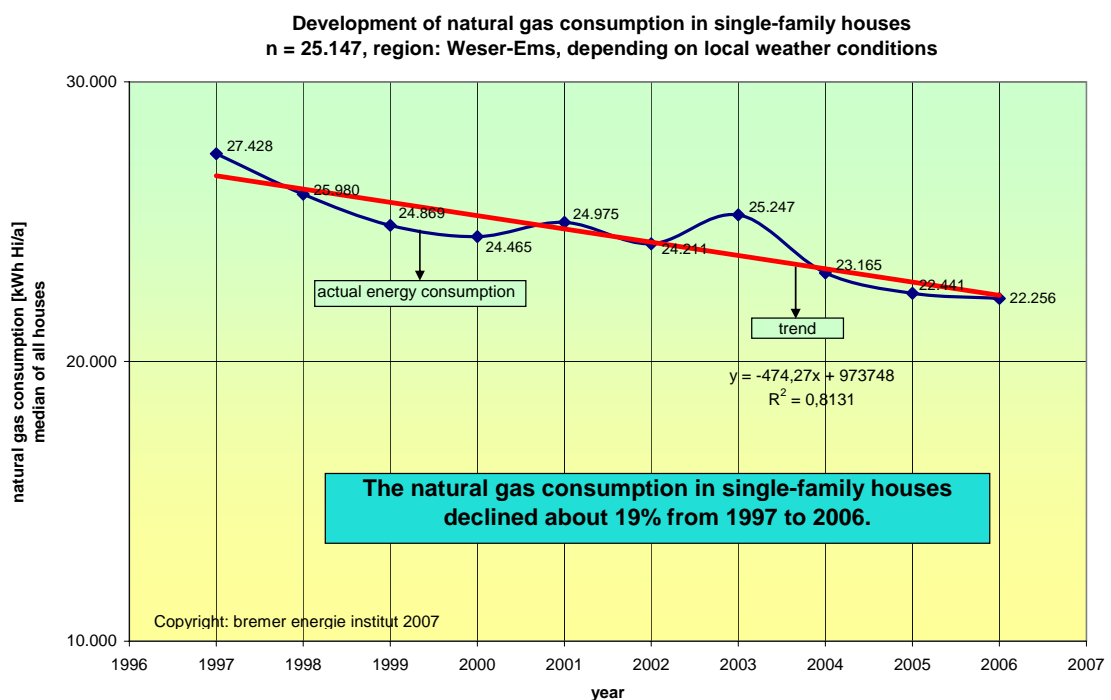


Figure 2: Development of natural gas consumption in single-family houses

Results of the interviews for influencing factors:

The consumption development was shown not to be dependent on a reduction of living space. In the contrary, reducing the final energy consumption even follows although the living space for ca. 8 % of the interviewees was augmented, while there were hardly any differences for the 5 groups.

On average, ca. 60 % of the interviewed performed at least one constructional measure during the period of 1997 to 2006, which influenced the energy consumption. There were clear differences between the groups: While 47% of the control group performed measures, only 21 % - 23 % of those, who saved 25 %, did not perform such measures.

For measures, which dealt with the modernization of heating techniques, the differences were especially outstanding between the control group and the "fast savers". Those "fast savers", which reduced by more than 25%, performed about doubly as frequent as the control group an implementation of new boilers, improvements of insulation of heating pipes, installation of new heating regulations and a change of hot water preparation.

Part of the development of the energy consumption should be due to sunk household sizes: For about 40 % of the households it has decreased. For the savers, the number of persons was more frequently reduced.

Concerning the reasons for a consumption reduction, *political instruments* “*financial boundary conditions*” and “*information*” were not of major significance:

The energy consultancy of the consumption centres, aided by means of the federal household, and the local energy consultancies can only be of minor importance since they have only been used of about 1 % of the households, which performed modernization measures.

Financial support was demanded by 11 % of those, who modernized their single-family houses in the period of 1997 – 2006. In most cases, a credit program were named by the local energy supplier EWE.

The financial instruments were used twice as often of those, who rapidly saved more than 25 % energy, as of households of the control group with constant energy consumption.

Considering the influencing factor “administrative rules”, the results of the interviews could not be easily interpreted: only 2 - 5 % of the interviewed (on direct question) stated constructional performances on the basis of legal requirements. Otherwise, about 20 % of those, who used boilers, claimed that boilers were introduced due to too high emissions; these account for 10 % of all modernizers. These “unequal” results may partly be traced back to the fact that most respondents did not know that the definition of “too high emissions” were also a result of administrative rules.

Certain effects of the administrative rules cannot be seriously acquired by interviews of households. Therefore, a requirement of earlier heating systems regulations (since 2002: “EnEV”) arranges for the installation of only certain products (e.g. until 2001 no standard boiler), without letting the household know about this. The requirement is in fact more directed towards industry and handcraft. The same is valid for the sector of heat protection: Re-fitting obligations were not present for the investigated domain of one-family houses. Still, there were and are conditional requirements, e.g. if windows are exchanged only those with a certain U-value may be installed (i.e.: with heat protection glazing). In total, the influence of the administrative rules may be negligible: However, they affect especially the heating domain at the moment, also because control checks (by chimneysweepers) take place.

As far as we know, our investigation represents the only study for historical consumption development in single-family houses.