Short report

Title
Analysis of the discrepancy between calculated energy demand according to EnEV and actual energy consumption

Reason / Initial situation
Studies have shown that there are discrepancies between energy demand, calculated according to EnEV, and measured energy consumption. Discrepancies can lead to irritation and reduce the acceptance of the EnEV. Furthermore, expected operating costs can often only be estimated with insufficient accuracy and a clear statement about the economic efficiency of energetic optimization measures is difficult to make.

Topic of the research project
In order to investigate the differences between energy demand and energy consumption, these are calculated for real buildings. Furthermore, based on the results, methods are developed to better match the calculation to the actual consumption.
To select the buildings, the building inventory in Germany was evaluated and the two building classes of single-family houses and apartment buildings were chosen, since these two classes represent a large number of buildings and apartments, respectively. In addition, the buildings were divided into three building groups, according to year of construction and energetic modernization status. Building group 1 includes all buildings that were built before 1995 and have not been energetically modernized. Building group 2 includes existing buildings and buildings that have been energetically modernized between 1995 and 2008. Building group 3 includes all new buildings and modernizations from 2009 and later. For the single-family houses, five buildings in building group 1, four buildings in building group 2 and two buildings in building group 3 form the data basis for the investigation. For the apartment buildings, ten buildings in building group 1, nine buildings in building group 2 and four buildings in building group 3 were investigated.
The buildings were analyzed using the calculation tool ZUB Helena Ultra, which can be used to generate EnEV-compliant energy certificates, and the thermal building simulation program TRNSYS. With the multiply validated program TRNSYS, the real conditions of the building can be recorded and investigated in more detail.
To detect the discrepancies, ZUB Helena was used to create energy performance certificates for all buildings. The actual consumption of the buildings was determined with the help of consumption bills from at least three years and corrected for location and weather conditions for the comparison. After this comparison it became clear, based on the available data, that buildings with a high (low) primary energy demand tend to have a lower (higher) consumption compared to the demand calculated according to EnEV.
The possible reasons for discrepancies were divided into the 3 influence groups of user influence, building envelope and technical building services. In each of the influence groups, the influencing factors deemed significant were varied in a positive and negative direction from an energy point of view. Furthermore, a combination of the three influencing groups was investigated. This procedure allows an overview of the size of the influence of the relevant influencing group as well as the superposition of influencing groups, in relation to the calculated demand. This investigation showed that the actual primary energy consumption for 12 of the buildings could be reconstructed by the superposition of all three influence groups. For 4 of the buildings, due to a very small discrepancy, the consumption could be reconstructed by the variation of each single influence group. For the remaining 18 buildings the actual consumption could not be reconstructed. However, the discrepancy was clearly minimized by the variations for these 18 buildings as well. By superimposing the three influence groups user, envelope and building services, the mean deviation across all buildings was significantly reduced.

Especially for the investigation of buildings for which the consumption could be reconstructed by the variation of each single influencing group, as well as buildings for which the consumption could not be reconstructed, an investigation of the single influencing factors in the different influencing groups was performed. This showed, for the available data, that the influence group user influence, or rather the influence factor mean room air temperature contained within this influence group, has the biggest influence on the calculation by far. Besides the dominant influence group user influence, the superposition of the influence groups building envelope and building services has a similar influence. For a better assessment, all influencing factors of the influence groups were varied individually.

Conclusion

Based on the available data, an improved energetic assessment of standard values of the building envelope and building services components is recommended for building groups 1 and 2. In addition, a more economical user profile should be taken into account, especially for buildings in building groups 1 and 2. For single-family houses in building group 2, a slightly reduced mean room air temperature of 19 °C should be applied. For the apartment buildings of building group 3, it would make sense to assume a slightly wasteful user (21 °C mean room temperature) and a slightly worse rating of the building envelope and building services components.

Key data

Short title: Discrepancy EnEV

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Part of federal funding: 148.437,04 €
Project duration: 24 months

Bilddateien

Bild 1: Diskrepanz EnEV Abbildung 1.png

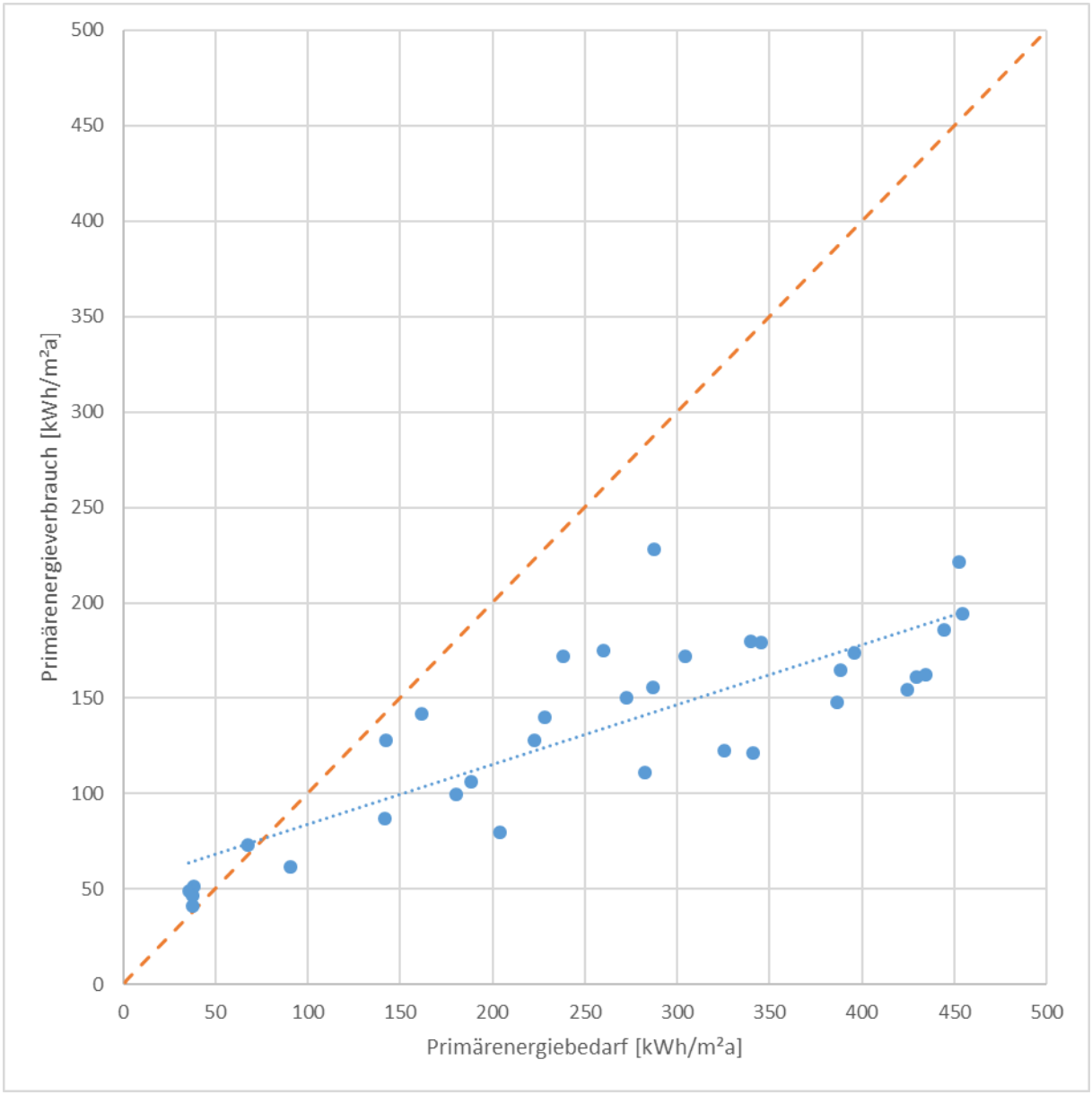

Figure 1: Comparison of all buildings: primary energy consumption (Y-axis) to primary energy demand (X-axis)

Bild 2: Diskrepanz EnEV Abbildung 2.png

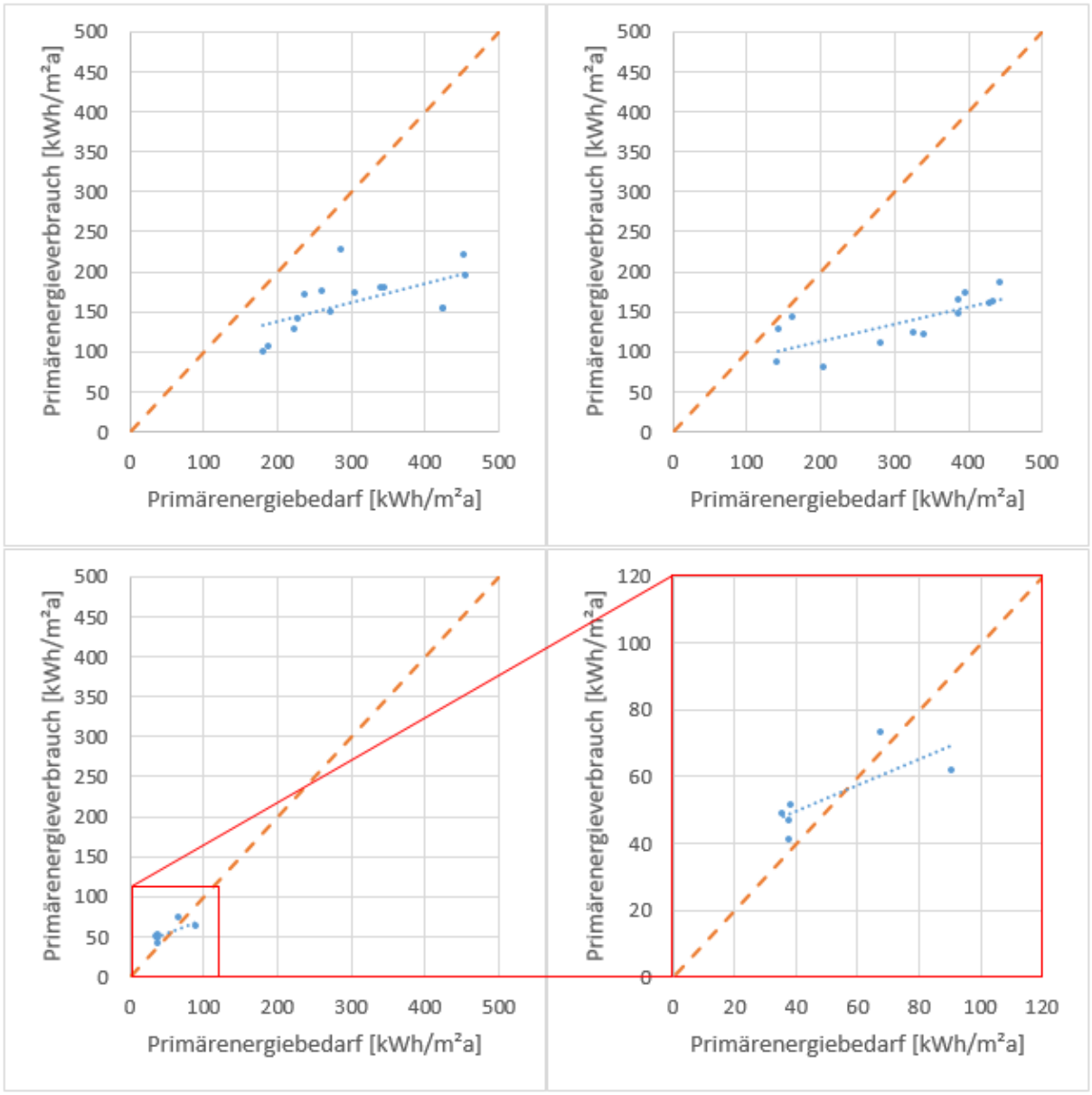

Figure 2: Comparison of primary energy consumption and primary energy demand for the building groups G1 (top left), G2 (top right), G3 (bottom left) and G3 enlarged (bottom right)

Bild 3: Diskrepanz EnEV Abbildung 3.png

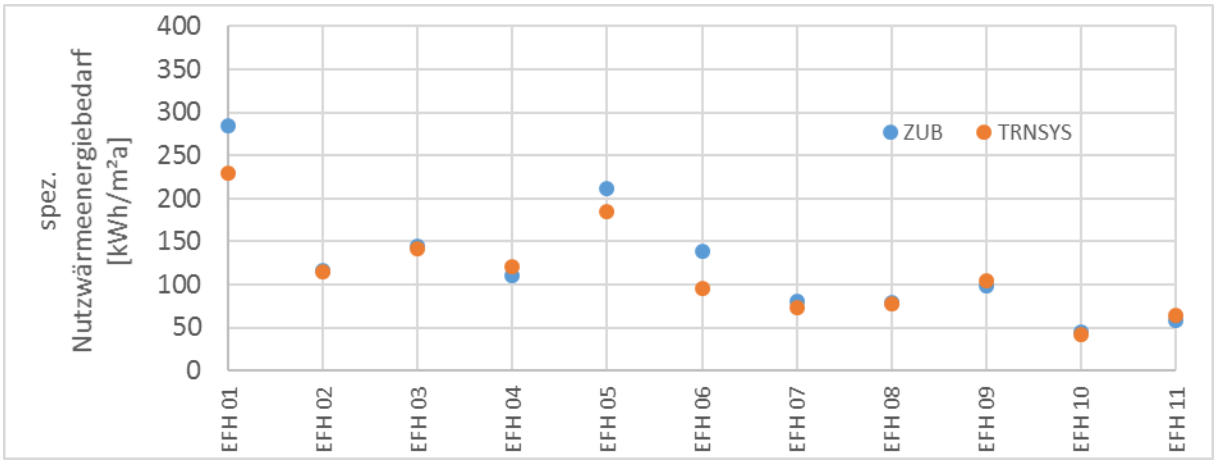

Figure 3: Comparison of the results of the calculation according to ZUB Helena and TRNSYS, under the same boundary conditions, for single-family houses

Bild 4: Diskrepanz EnEV Abbildung 4.png

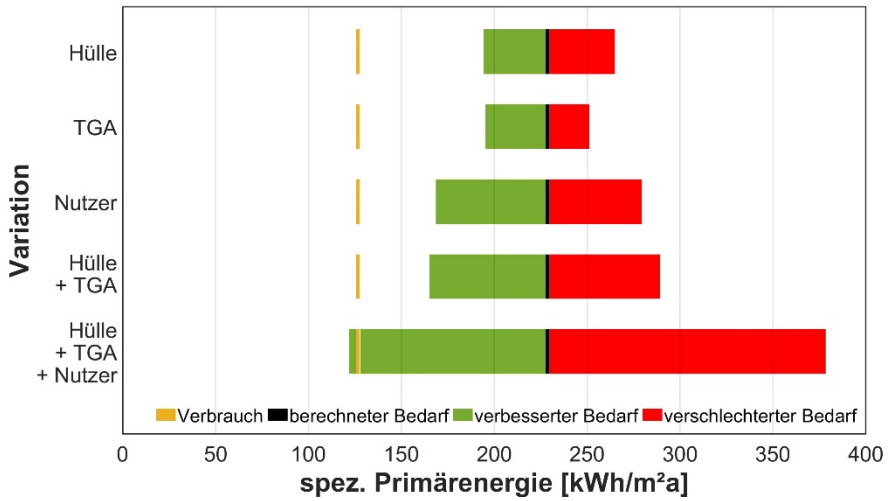

Figure 4: Example of an influence analysis (MFH G1 08), consumption was reconstructed by superposition of the variation of all three influence groups

Bild 5: Diskrepanz EnEV Abbildung 5.png

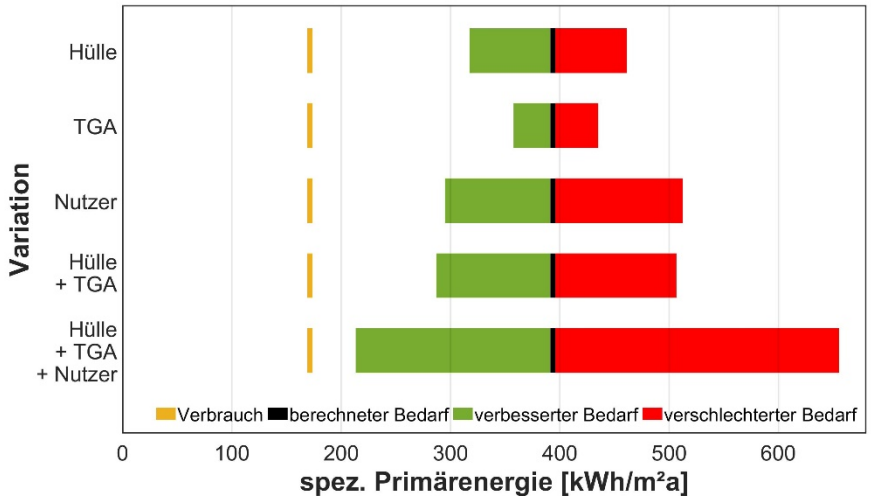

Figure 5: Example of an influence analysis (MFH G2 01), consumption not reconstructed by superposition of the variation of all three influence groups

Bild 6: Diskrepanz EnEV Abbildung 6.png

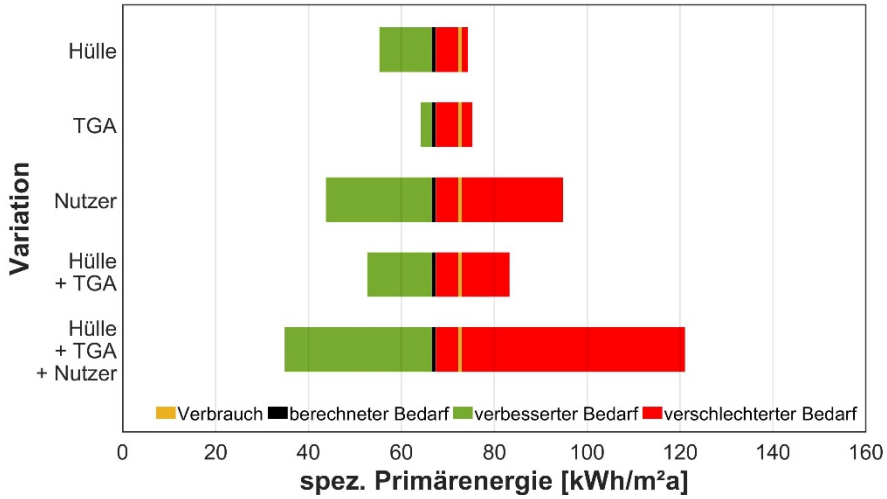

Figure 6: Example of an influence analysis (EFH G3 01), consumption reconstructed by the variation of each single influence group

Bild 7: Diskrepanz EnEV Abbildung 7.png

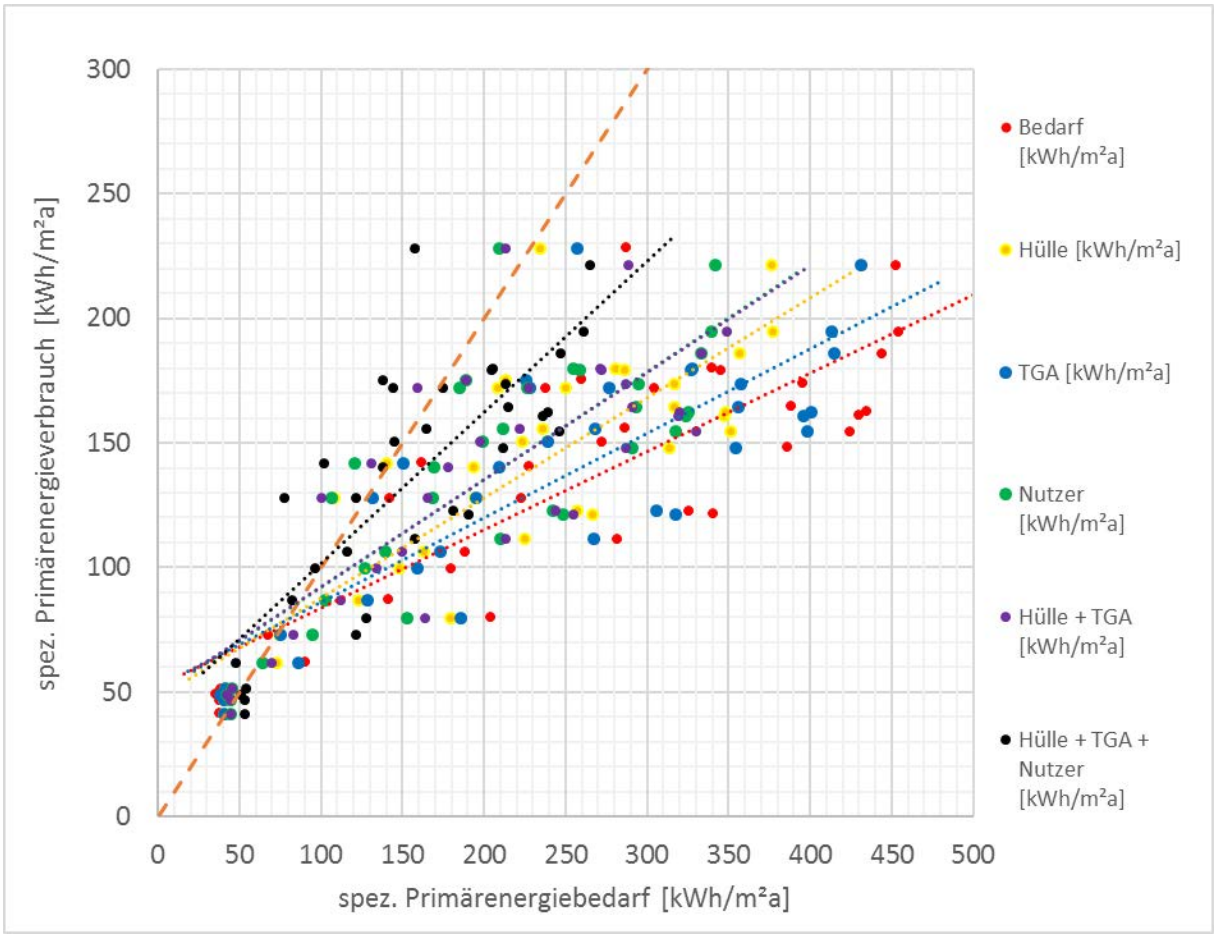

Figure 7: Comparison of reference energy demand values (red) to the varied influence groups: building envelope (yellow), building services (blue) and users (green) as well as the superposition of envelope and building services (purple) and superposition of all three influence groups (black) for all buildings