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COMPILATION OF HYGROTHERMAL REFERENCE YEARS (HRY) IN GERMANY

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BACKGROUND

Energy-efficient buildings are one of the key elements of Germany's energy policy. In line with the energy concept developed by the German Federal Ministry of Economic Affairs and Energy *[1]*, the heating requirements of residential buildings are to be reduced by 80 percent by 2050. In addition to transmission heat losses, ventilation heat losses e. g. by infiltration have to be reduced too.

While the current version of the EnEV-standard still allows an air exchange rate of $n_{50} = 1.5\ h^{-1}$, for more energy-efficient buildings, such as passive houses, only an air exchange rate of less than $0.6\ h^{-1}$ is permissible. At the same time, a WHO study *[3]* recommends sufficient air exchange after insulation measures in order to prevent mold growth. This contradiction demonstrates the importance of the hygrothermal design of the building envelope right from the start of the planning phase.

To simulate hygrothermal properties realistically, representative boundary conditions are called for, which were not always available in the past. Thanks to the "Climate Models" *[4]* project funded by the BMWi, this gap has now been closed. A key part of the project was the compilation of "hygrothermal reference years (HRY)".

DATA BASE USED

Weather data from Meteomedia were used because this was the only source of normal rainfall and radiation data over a sufficiently long period of time. To compile the HRY, 17 sites with eight-year time series were chosen. These were all close to the reference stations used by the "DWD – Deutscher Wetterdienst" (German weather service) for their "thermal test reference years (TRY)".

This makes it possible to use the TRY zonal classification as a starting point for HRY. Gaps in the measurement were closed by linear interpolation. Longer measurement outages were supplemented by "mean days". For this purpose, mean values of the same calendar day were taken from the other available 8-years period and the measurement failure was closed with this "mean day". The atmospheric counter radiation lacking in the measurement data was added, based on a DWD model *[5]* with a specially developed and validated approach.

METHODOLOGY COMPILING THE HRY

Metrics e. g. the 25 % and 75 % quartile were calculated for the respective month, e. g. January, from 2003 to 2010 and then compared with the metrics for January averaged over the entire period. The month with the smallest deviation from the mean month was then selected as the month for

the HRY. This procedure is summarized in Diagram 1.
After compiling the HRY from the separate months, the month and year transitions were smoothed to avoid unrealistic spikes in the various climate parameters.

VALIDATION BY SIMULATION

The suitability of the new HRY for evaluating building components was then verified by performing hygrothermal building component simulations using WUFI® *[6]*. For this purpose, the critical layers of four sensitive structures were considered. These were:

- a pitched roof with sheet metal roofing,
- a greened roof,
- a flat roof with light-colored roofing material and
- a west-facing exterior wall.

The water content in the most critical layer of the building component was evaluated, as shown in Diagram 2 for a sheet metal roof at the Braunlage site.

The graph shows that the HRY leads to a similar water content in the component as when using the measured eight-year data sets. This evaluation was carried out for all four structures mentioned at the fifteen reference sites as well as at two other sites as a comparison.

ZONAL CLASSIFICATION

In order to cover the entire Federal Republic of Germany with fifteen reference stations, the zonal division defined by the DWD for the test reference years was used. Since the range of simulation results from some structures was relatively narrow, it was possible to reduce the number of zones. For the specific application area of hygrothermal building component simulation, eleven zones and reference stations remain. These are listed in Table 1.

EVALUATION PERIOD

To take into account the influence of particularly cold years which occur approximately every 10 years, e. g. 2006 in Diagram 2, cold HRY were developed as described in EN 15026 *[7]* and combined with the HRY to form evaluation periods. The approach taken from the standard turned out to be highly suitable. Compared with the excess duration of critical water content in the component layers, the combination of three normal, two cold and a further three normal HRY showed the best match with the measured time series.

CONCLUSION

The new hygrothermal reference years compiled in the research project "Climate Models" *[4]* give a clear picture of the performance of the building components compared to the real eight-year data sets. To measure building components, the above-mentioned combination of cold and normal HRY is recommended, since this also takes particularly cold weather periods into account. To evaluate other aspects, such as the impact of humidity on heat transfer, long-term performance, or typical load situations, the use of normal HRY is more appropriate.

It was possible to reduce the number of zones for the HRY compared to the TRY zones, thus enabling the entire area of Germany to be covered by eleven reference stations.

1 Weather station near Holzkirchen for measuring local weather conditions.

2 The eleven HRY climate zones in Germany with their reference sites.

Diagramm 1 Sequence of the month selection

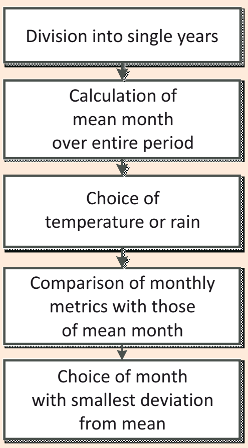

Diagramm 2 Comparison of water content

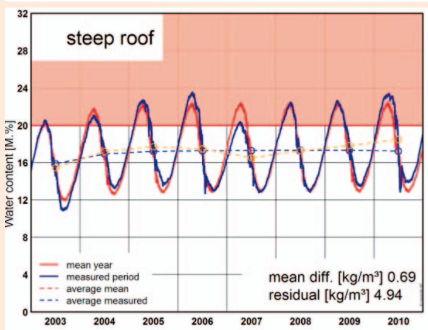

Tabelle 1 HRY zones and reference stations

HRY No.	Station
1	Warnemünde
2	Hamburg
3	Potsdam
4	Braunlage
5	Kassel
6	Chemnitz
7	Fichtelberg
8	Mannheim
9	Fürstenzell
10	Stötten
11	Lindenberg