

## Comparison of measured energy consumption values using the PHPP heating energy balance (requirement value)

### Pre-requisite

To compare the consumption and requirement values gathered in the planning stage, a **very realistic and current PHPP** of the entire building must be provided upon completion of construction. The PHPP must take into account all deviations from the plan (i.e. additional or altered thermal bridges, changes in insulation materials or airtightness).

The measurements must

- differentiate between domestic water heating and heating supply and
- the consumption values must remove conversion, distribution and storage losses, so as to obtain the effective heat value.

For further information on the subject of relevant interferences, please refer to protocol volume No. 45 “Accurate measurements in energy efficient buildings” [Peper 2012] of the cost-effective Passive House buildings working group “measurement concepts, disturbance variables and adequate solutions”.

### Procedure

#### 1. Weather conditions

**1.1 Acquisition of the measured “outdoor temperature” and “horizontal global radiation” weather conditions.** During the monitoring stage, data of the building’s location must be provided in the form of monthly values (identical to measured energy values).

**Simplification 1 A:** In case the weather conditions were not measured at the building itself, measurements of the nearest weather station must be used instead. The suitability of the data is to be examined in each case (e.g. distance, height above sea level, etc.).

**1.2** Insertion of the measured weather conditions as a set of separate climate data in PHPP’s climate sheet (monthly values). After inserting the data, the climate data set needs to be named and selected.

**Simplification 1 B:** Sky temperature and dew points can be omitted in northern Europe.

**Simplification 1 C:** In case global radiation data cannot be ascertained as per the four compass directions, the distribution of horizontal radiation can be made in proportion to the four compass directions by using the original distribution of the global radiation data. The ratio of the global radiation to the respective compass direction will be transferred horizontally onto the measured global radiation.

## 2. Indoor temperature

The indoor temperature measured during the heating period (usually between 1 October and 30 April) must be entered into PHPP (verification sheet; indoor temperature winter). The average temperature of the building must be representative. A single measuring station in a non-representative room is not suitable. When using multiple measuring stations, the amount of heat losses must be taken into account. Ideally, median indoor temperatures are weighted for the estimated thermal heat conductance of the attached rooms:

$$T_{eff} = \sum_n \frac{(H_{Tn} * T_n)}{H_T} \quad (\text{Median temperature weighted for transmission conductance})$$

Ventilation losses and infiltration also need to be taken into account.

**Simplification 2 A:** If the rooms of a building are being heated equally and the building is equipped with a highly insulated thermal envelope, averaged indoor temperatures may be used for the calculations.

## 3. Electricity consumption

The effective electricity consumption contributes to the amount of internal heat sources. In a conventional residence building, these amount to a value of 2.1 W/m<sup>2</sup>. If measurements of the effective electricity consumption are available, they may be taken into account as well. To obtain the effective electricity consumption, the data in the electricity sheet needs to be adjusted accordingly.

A calculation of the effective internal heat sources is suitable if a reliable estimation of all sources can be made.

**Simplification 3 A:** By entering a “miscellaneous” consumer, electricity consumption will be set to its effective value (electricity sheet; miscellaneous section). Due to the data input in the electricity sheet, the results in the internal heat sources sheet will change as well. Availability is to be set to a typical value of 0.8. For negative values of the correction (lower consumption), the value for “within the thermal envelope” must be adjusted in the internal heat sources sheet, as it will not be taken into account otherwise (the line must not contain a “0”).<sup>1</sup>

<sup>1</sup> An addition can be made to the formula with the first „>“, so that a “<>” will be used.

To use the effective internal heat sources for the PHPP calculation, “PHPP calculation (verification sheet)” must be selected in the “internal heat sources / type of used values” menu of the verification sheet.

#### 4. Occupancy rate

If known, the **effective** occupancy rate can be entered into the verification sheet of PHPP as well. The changes in the occupants’ heat transmission and usage intensity will be taken into account when calculating internal heat sources (refer to 3. for the conversion between internal heat sources and electricity).

### Comparison

After these adjustments to the set of climate data, to the indoor temperature and possibly to the internal heat sources (electricity consumption) have been made, PHPP will show the heating demand of the object with changed parameters in the verification sheet. This value can only be compared to the measurement (heating demand). The highest overall accuracy of the balance calculation amounts to 3 kWh/m<sup>2</sup>a. The overall accuracy of the measurements depends on the instruments and cannot be universally indicated. The amount of deviations left indicates if further investigations need to be made.

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