Average building specific usage profile calculation methodology

A total of $N_\mathrm{u} = 43$ standard usage profiles characterized by $N_\mathrm{p} = 28$ usage specific parameters are defined in DIN V 18599. These parameters include usage and operation hours of the building as well as indoor environmental qualitiy requirements. These usage profiles and parameters can be expressed as a matrix P in the form

$$P = \begin{bmatrix} p_{1,1} & \cdots & p_{1,N_P} \\ \vdots & \ddots & \vdots \\ & \cdots & p_{N_u,N_p} \end{bmatrix} \tag{1}$$

with the entry $p_{i,j}$ being the usage parameter j of usage i.

The first database contains the areas of each usage for a total of $N_\mathrm{FO} = 86$ building categories as defined by the Federal Office for Economic Affairs and Export Control. These areas can be represented as a matrix in the form

$$A = \begin{bmatrix} a_{1,1} & \cdots & a_{1,N_u} \\ \vdots & \ddots & \vdots \\ & \cdots & a_{N_\mathrm{FO},N_u} \end{bmatrix} \tag{2}$$

with $a_{f,i}$ being the of area of usage i in the building category f in the FO domain.

The usage parameters defined in DIN V 18599 refer to a total of three different reference values. Some parameters (e.g. presence times) refer to user presence days, whereas most refer to the hours when the user is present. The design temperatures used for the estimation of the maximum heating and cooling load refer to a singular event. Therefore, a weighting factor is chosen

$$w_{f,i,j} = \begin{cases} a_{f,i} \cdot d_i, & j \in \{1,2,3,5,6,7,9,27,28\} \\ a_f, & j \in \{20,21\} \\ a_{f,i} \cdot h_i, & otherwise \end{cases} \tag{3}$$

that takes into account the three before mentioned different reference values. In equation (3), $w_{f,i,j}$ denotes the weighting factor of usage i, for the building category f and the usage parameter j. In case that parameter j refers to user presence days, $w_{f,i,j}$ equals to a day-based areal intesity with d_i being the number of user presence days per year. In case of parameter j being a design temperature, $w_{f,i,j}$ equals to an areal weight. For all other parameters, $w_{f,i,j}$ equals to an hour-based areal intesity with h_i being the number of user presence hours per year. The normalized weighting factor is calculated by

$$\widehat{w}_{f,i,j} = \frac{w_{f,i,j}}{\sum_n^{N_u} w_{f,n,j}} \tag{4}$$

With these weights, the intensity weighted usage parameters for the $N_\mathrm{FO} = 86$ building categories can be computed through

$$\tilde{p}_{f,j} = \widehat{w}_{f,i} \cdot p_{i,j} = \sum_{i=1}^{N_u} \frac{w_{f,i,j}}{\sum_n^{N_u} w_{f,n,j}} \cdot p_{i,j} \tag{5}$$

with $\tilde{p}_{f,j}$ being the intensity weighted usage parameter j of the building category in f in the FO domain.

The building categories in the FO-domain are denoted with the prefix FO and the building categories in the second domain with ENOB:DataNWG. In the following, an assignment between both domains is performed. An exact one-to-one assignment is not possible as the two building domains contain different numbers of elements. Additionally, some elements are similar, but not identical. In some cases, several FO categories are assigned to one ENOB:DataNWG category. In other cases, a group of FO categories is assigned to multiple ENOB: DataNWG categories, resulting in these ENOB: DataNWG categories to be identical (see Fig. 1).

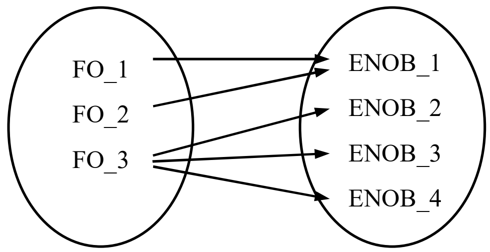

Figure 1: Schematic of assignment between the two different building data basis.

The association between both domains is denoted by the matrix $M \in \mathbb{R}^{N_{\mathrm{ENOB}} \times N_{\mathrm{FO}}}$. The entry $m_{\mathrm{e,f}}$ of matrix M denotes the share of building category f (FO) in building category e (ENOB: DataNWG). Finally, the intensity weighted usage parameters for the $N_{\mathrm{ENOB}} = 107$ building categories can be computed through

$$\tilde{p}_{e,j} = m_{e,f} \cdot \tilde{p}_{f,j} = \sum_{f=1}^{N_{FO}} \sum_{i=1}^{N_u} m_{e,f} \cdot \frac{w_{f,i,j}}{\sum_n^{N_u} w_{f,n,j}} \cdot p_{i,j} \tag{6}$$