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# **Comprehensive analysis energy efficiency of large buildings / halls Summary**

on behalf of: FIGAWA  
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The responsibility lies with the author.

**Project data**

Whole title:	Analysis on large buildings (halls), their building characteristics and specific HVC instalation systems for the purpose of the target-oriented exploitation of the overall saving potential of energy consumption and CO <sub>2</sub> emissions as part of updating the standards series DIN V 18599 / EnEV 2012
Short title:	Comprehensive analysis on energy efficiency of large buildings (CAEEH)
Project management:	Dresden Institute for Building Systems Engineering Research and Application GmbH Bayreuther Straße 29, 01187 Dresden  Prof. Dr.-Ing. Bert Oschatz
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Project duration:	16.12.2009-30.06.2011

## Preliminary remark

The present study deals with issues regarding the heating of halls, to be understood as a certain group of buildings, such as:

- warehouses / logistics centres
- industrial halls
- sports halls
- market halls
- ...

In the following, this group of buildings is referred to as *large buildings* or *halls*.

## 1 Issue and Intention

Regarding calculation of energy demand of large buildings according to DIN V 18599, several difficulties occur for building structure, form of usage and specific installation systems not being taken into account adequately. Within the present research project fundamentals to revising the DIN V 18599 are to be developed and suggestions on opening capabilities of energy savings are to be made.

## 2 Procedure

The present research project includes a series of analyses on a vast number of main and particular issues, regarding heating of large buildings in general as well as calculation of energy demand according to DIN V 18599 in particular. In what follows, important issues are listed (partly in bullet point form) and described briefly.

Based on analysis of statistical data the overall situation in Germany regarding heating large buildings is evaluated. This evaluation contains a comparison between energy consumption of real-world halls and corresponding energy demand according to DIN V 18599 as well as qualified estimate on overall heating energy consumption of large buildings. Furthermore, the overall saving potential is valued. Apart from considerations regarding existing buildings, a consumption forecast on future building stock describing increasing level of requirements – as with implementation of EPBD guideline till ~2020 – is made. Measures regarding present building stock are compared to future measures in terms of saving potential.

Based on a literature analysis present knowledge on the heating of large buildings is worked out.

Based on a building catalogue – created as part of the present study – covering main applications for large buildings in a representative way further analysis is done, e.g.:

- calculation of energy demand according to DIN V 18599:2007/2009 (documenting current state)
- thermal simulation of buildings without inclusion of (specific) heating systems
- based on the above parameter variations of:
  - air exchange rate
  - heat storage capacity

- inquiry on the applicability of the usage profiles given in DIN V 18599-10 for typical applications of large buildings

In parallel theoretical analyses on essential issues regarding the calculation process according to DIN V 18599 are done; special attention is, inter alia, given to:

- cause variables of weighting application typical heat emissions systems
  - air temperature profile/gradient
    - derivation of a method to calculate heat loss (within process of heat emission) based on system-specific air temperature gradients
    - evaluation/interpretation of comprehensive measurement and simulation results; formulation of default values of air temperature gradients to be used within the abovementioned approach
  - percentage of radiation of heat emission
    - derivation and evaluation of a method to calculate the factor of radiation influence ( $f_{\text{Radiant}}$ ) given in DIN V 18599-5 for luminous infrared heaters and radiant tube heaters, allowing for differentiating grading between heaters of different efficiency levels
- estimation of heat generation loss of decentralised heating systems for large buildings
  - correction of a mistake within DIN V 18599:2007/2009 (heating / caloric value)
  - expansion of the approach given allowing for better inclusion of modern common heating systems
- ventilation heat loss in large/compact buildings (halls)
  - questioning of the approach of calculating ventilation heat loss given in DIN V 18599:2007/2009
  - derivation of an alternative approach being more suited for halls in terms of physical correctness
  - formulation of default values (air tightness levels) to be used within the abovementioned approach

Already during an early state of progress gained cognitions are extracted in the form of standard modification proposals and distributed to the responsible DIN committees. The before mentioned extracts (modification proposals) are updated during the whole project duration and accommodated the level of progress. These proposals contain, in particular, modifications to the grading of heating systems in terms of efficiency (DIN V 18599-5). Both particular and main results are being discussed continually with a project group consisting of experts in the fields of hall heating and building physics.

Utilising a comprehensively enhanced version of the commercial simulating tool TRNSYS elaborate instationary building simulations (with hall specific heat emission systems) are run. Here, complete heating periods are simulated for the first time. Based on a comparison of these simulation results with results according to DIN V 18599 – all proposed modifications being taken into account – partly iterative adjustments of the grading of heating system efficiency according to DIN V 18599 are made; e.g. by adjusting calculation methods respectively parameters used.

### 3 Essential results and conclusion

The evaluation on the overall situation of heating large buildings confirms the known issue of overestimating real-world energy consumption with calculation of energy demand according to DIN V 18599. Furthermore, it is demonstrated that large quantities of energy consumption are used heating halls and considerable energy saving potential is given. In addition to this, it is pointed out that the saving potential on measures regarding current building stock is considerably larger than the saving potential on future measures.

As a result of wide analysis and evaluation on the method of calculating energy demand according to DIN V 18599 and dimensions and parameters used within, comprehensive standard modification proposals have been made and implemented within the draft standard DIN V 18599:2011. Regarding the efficiency grading of halls according to DIN V 18599, the study shows, inter alia, the following:

- Main types of real-world hall usage profiles can, with reservations, already be modelled with DIN V 18599:2007/2009. By means of adjustments and additions, capability of modelling halls in terms of usage parameters was increased.
- The determination of storage-capable building mass is, according to DIN V 18599, done in a very inaccurate way. Within the present study, a much more precise method was introduced and evaluated. Given the fact that storage-capable building mass, within realistic limits, has only little impact on energy demand, the “old approach” can still be used with sufficient accuracy.
- An alternative method of calculating interior temperature, introduced as part of the present project, was evaluated and showed slightly better results than the approach already implemented in DIN V 18599. However, there was only little effect and, thus, no modification proposal on this was made.
- The present Method of calculating infiltration airflow, given in DIN V 18599-2:2007/2009, which is based on very general values of volume related air exchange rates, is inappropriate for large buildings. A physically more plausible method was developed and has been formulated as standard modification proposal.
- The grading of hall heating systems according to DIN V 18599-5:2007/2009 is revision-worthy with regard to several issues. Corresponding standard modification proposals have been made, such as:
  - Corrections (e.g. heating/caloric value)
  - Revision of the categorisation of hall-specific heat emission systems, thus creating or improving the modelability of customary heating systems (e.g. inclusion of condensing technology in decentralised heating systems)
  - Questioning/Revision of the calculation methods and parameters used within (stronger differentiation between systems respectively system variations in terms of efficiency)
  - Simplification of the approaches used for calculation of auxiliary energy of hall heating systems and heat generation losses of decentralised hall heating systems

The modifications made mainly affect grading of heating system efficiency (DIN V 18599-5). However, important modifications have also been applied to DIN V 18599-2 (→ ventilation

heat loss) and DIN V 18599-10 (profiles and parameters of usage). Primarily the modifications made cause

- in many cases lower energy demand (better correlation between consumption and demand)
- better capability in modelling real-world usage patterns with usage profiles given (DIN V 18599-10)
- better capability of modelling hall-specific heat emission systems, including reasonable differentiation in terms of system specific energy efficiency.

The responsible standards committees have accepted the standard modification proposals made as part of the present study.