Harmonizing the Assessment Methods for Standards – Building Design Days as a Bridge Between Load and Energy Assessment

The existing assessment procedures for buildings—such as DIN EN 12831 for heating load, VDI 2078 for cooling load, the German Building Energy Act (GEG) for annual energy performance, and DIN 4108-2 for thermal insulation and comfort assessment—are based on fundamentally separate methodological approaches. Heating and cooling load calculations follow a peak-value mindset and provide instantaneous sizing values for extreme design conditions, whereas the energy performance assessment relies on periodic averages and aggregated climatic representations. This methodological split is historically understandable, but it leads to inconsistencies between load-based and energy-based evaluations and frequently results in **oversized technical systems**, conservative design choices, and reduced transparency in planning decisions. The underlying challenge is that buildings never operate in isolated peak moments; instead, they behave dynamically over the course of each day and year.

The new method Building Design Days + Energy (BDD+E) offers a pathway toward harmonizing these procedures: It is based on a structured set of systematized Climate Design Days (CDD) that provide hourly resolved and physically representative daily profiles for heating (extreme winter day), cooling (extreme summer day), and transitional period conditions (normal winter day, a series of five typical monthly transitional period days, and normal summer day). The required climatic characteristic parameters can be derived from datasets available not only for Europe but also globally. These synthetic yet statistically accurate Climate Design Days are created from just a few characteristic parameters and reproduce the essential features of real climate data without their random variability. This method is further supported by an evaluation of historical climate records from 1945 to 2024, from which long-term climatic trends have been systematically derived. On the basis of these Climate Design Days, an **hourly static heat balance** of the building—or of individual thermal zones—is performed. Methodologically, the approach relies on the established mathematical formulations embedded in the relevant standards, extending them from single-moment evaluations to full 24-hour profiles and assembling these into a coherent representation of an entire year. The method generates a unified data basis from which both **load sizing** and **annual energy assessments** can be derived, thereby overcoming the traditional separation between instantaneous value considerations and long-term considerations. Because the underlying physical principles are universal, the method BDD+E is applicable across Europe and worldwide, enabling consistent assessments under diverse climatic and regulatory contexts.

The result is a consistent and physically grounded calculation model that brings together the requirements of the heating-load standard, the cooling-load guideline, the Building Energy Act, and thermal comfort criteria. By computing full 24-hour load profiles instead of a single momentary snapshot, the method provides insight into the temporal development of room conditions, the interaction between transmission, ventilation, and internal loads, and the extent to which heating and cooling systems must intervene to maintain comfort targets. By the transparency given, the new method helps clarifying **cause-and-effect** relationships. This enables a more realistic dimensioning of room-side heat transfer systems, HVAC components, and operating strategies. In addition, because the same dataset is used for annual energy calculations, the method BDD+E delivers consistent annual heating and cooling energy demands, frequency distributions, partial-load operating characteristics, and correlations between outdoor conditions and system performance. For generation systems such as heat pumps, whose efficiency and lifespan depend strongly on partial-load operation, this unified approach provides a more reliable and transparent basis for design.

Thus, the new method BDD+E establishes a methodological link between normative peak-load procedures and annual energy assessments. It offers the potential to harmonize existing verification frameworks and paves the way for future standards that integrate load, energy, comfort, and control considerations more coherently. At the same time, the approach bridges conceptual gaps between static load calculations and dynamic, usage-oriented simulations. For a **robust and sustainable system design** process, the results of currently applicable standards are always compared side by side with the enhanced method, ensuring compatibility while highlighting the benefits of a more physically consistent approach.

Beyond the planning process, the digital physical twin developed during the design phase can later be calibrated and validated during building operation. By comparing calculated hourly load profiles with measured energy-monitoring data, energy managers gain direct insight into cause-effect mechanisms, allowing them to adjust model parameters such as occupancy intensity, internal loads, or operating schedules until the calculated and measured behaviours align. This establishes a continuous connection between design assumptions and real-world operation and enables systematic fault detection as well as optimization of control strategies. If a BIM model is available, the results can be integrated with it – divided into individual rooms, usage areas, or heating circuits.

The new method BDD+E provides additional value in the early design phase by supporting simplified models with a modest number of thermal zones, allowing realistic variant studies even before detailed simulation tools are employed. At the same time, the transparent physical structure of the approach makes it suitable for teaching and research settings. Starting in the summer semester of 2026, the method will be incorporated into university-level instruction at at least one higher-education institution (Bochum University of Applied Sciences, Faculty of Architecture, in the modules Building Physics & Energy-Efficient Buildings, Prof. Volker Huckemann, and Sustainable Building Services Engineering, Prof. Christian Koch), supporting students in intuitively understanding the interplay between loads, energy, and control in modern building systems.

Further information:

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