Fraunhofer Institut
Bauphysik

**Short version of IBP report
WB 136/2007**

Short report

**Electronic checklist for buildings and related
plant systems as a basis for calculations
acc. to German standard DIN V 18599**

**Heike Erhorn-Kluttig
Anna Staudt
Florian Stoessel
Hannah Weber
Hans Erhorn
Simon Woessner**

1 Aim of the research project

On 18 December 2002 the European Council and the European Parliament adopted the Energy Performance of Buildings Directive (EPBD), which was published in the Official Journal of the European Union on 3 January 2003. This directive calls on all member states to transform the following items into national law by the beginning of 2006, namely

- the assessment of the energy performance of buildings, which comprises the following energy components: heating, cooling, ventilation, lighting and domestic hot water;

- the issue of an energy performance certificate (i.e. a certificate stating the energy efficiency of a building) when planning a new construction, the purchase or rental of buildings, or substantial renovation; as public buildings are to set a good example, these will also receive an energy performance certificate;

- a periodical energy efficiency check for heating systems and air conditioning systems.

In Germany, the energy performance assessment of non-residential buildings (new constructions) is performed on the basis of German standard DIN V 18599. This standard was compiled by three co-operating standards committees: the Building and Civil Engineering Standards Committee NA Bau (Normenausschuss Bauwesen), the Standards Committee for Heating and Ventilation NHRS (Normenausschuss Heiz-, Raumluft- und Sanitaertechnik), and the Lighting Technology Standards Committee FNL (Fachnormenausschuss Lichttechnik).

DIN V 18599 allows a holistic and detailed assessment of a building's energy performance including the interaction between building and building services plants. As this purpose requires the representation of a broad variety of structural and plant-specific parameters in particular, a great number of planning parameters need to be collected as input data for the algorithms.

When assessing the energy performance of existing non-residential buildings, it is not only possible to issue a building energy label ('Verbrauchsenergie-ausweis', based on normalised measurements of the energy consumption, like bills issued by the energy provider); there is also the option of issuing the energy performance certificate ('Bedarfsausweis', based on the assessment method specified in German standard DIN V 18599). The energy performance certificate implies a great advantage: various energy saving measures can be explicitly quantified at the building proper. Here, however, a totally different method of preparation is needed, due to the fact that in existing buildings the majority of the assessment parameters required as input values for the calculation formulae acc. to DIN V 18599 cannot be determined on the basis of detailed, up-to-date planning documents; instead, they have to be compiled on the basis of a detailed building inspection and any documents that are still available.

To simplify the input-data collection required acc. to the DIN V 18599 assessment method (particularly during the on-site building inspection) and to ensure consistent quality, a checklist including all necessary parameters was

compiled within the framework of the research programme entitled "Zukunft Bau (Future of Building)" initiated by the German Federal Ministry of Transport, Building and Urban Affairs, implemented by the German Federal Office for Building and Regional Planning (Bundesamt fuer Bau und Raumordnung, BBR). The paper version of the checklist has been enclosed with the present report. The main objective of the funding project was however to compile an "electronic checklist for the inspection of buildings and related plant systems". The electronic version of the checklist can easily be carried along to the building inspection on any portable computer, thus allowing the direct input of all parameters and further important information like descriptions, linking inform-ation directly to sketches, photos, etc. and much more. Via an output interface the entered parameters can be transferred directly to calculation routines. Responsibility for this domain however rests with the software providers, as the work scope of this funded project ends with the precise definition of the respective interface.

2 Implementation of the research project

2.1 Time frame

The work for the research project started in March 2007. The worksteps specified in section 2.3 and the two working group meetings requested by the funding agency were performed by the end of October. The final report and the definition of the interface with related DIN V 18599 assessment programmes were completed by the beginning of December 2007.

2.2 Project partners involved

In addition to the institution that was in charge of the technical project lead (namely the Fraunhofer Institute for Building Physics IBP) also the working group that accompanied the project, namely

- Bundesamt fuer Bau und Raumordnung, BBR
  (the German Federal Office for Building and Regional Planning)

- Institut fuer Erhaltung und Modernisierung im Bauwesen, IEMB
  (Institute for Maintenance and Modernization in the Building Sector)

- Schiller Engineering

- Ingenieurbuero Schmidt-Reuter (consulting engineers),

- Fachinstitut fuer Gebaeudeklima, FGK (Institute for Indoor Climate)

had their share in ensuring the successful implementation of the project by delivering contributions and practical tests. On the occasion of two working group meetings, practical experience concerning building inspections in general and the first application of the electronic checklist was shared, thus improving the tool's content and usability.

2.3 Worksteps

The worksteps can be grouped as follows:

1. All work is based on the experience hitherto gained by the Fraunhofer Institute for Building Physics IBP (and by the supporting working group) from former building surveys. Partially, this experience was directly related to calculations acc. to DIN V 18599 (quite a new tool) or based on previous methods of assessment and detailed simulations of existing buildings.

2. The next step was the analysis of previous checklists, which has been summarized under item 3. Some of these lists were compiled by Fraunhofer Institute for Building Physics IBP, some were prepared by external authors for similar tasks and buildings.

3. Subsequently, a first paper version of the checklist was created and submitted to both Fraunhofer IBP and the working group for further testing. While the working group test resulted mainly in feedback relating to the experience gained so far, Fraunhofer IBP conducted a detailed test on the basis of an energy performance certificate issued for an existing building.

4. The working group feedback and the results of Fraunhofer IBP's practical test based on an energy performance certificate resulted in an enhanced paper version of the checklist.

5. The revised paper version was thereafter converted into an electronic version. Great attention was paid to include any experience gained when preparing the paper version, while also using the benefits of the electronic format (for instance, automatic compilation of parameters in tables, input inquiries depending on previously entered input values for a better overview, linkages to schemes, photos, etc.).

6. Subsequently, the electronic checklist was tested by the working group and their feedback was included in the final electronic version.

7. The interface of the input parameters with DIN V 18599 assessment tools was defined to enable software developers to transfer these parameters directly to their tool.

8. Eventually the final report was drafted, submitted to the funding agency to include optional commentaries, and then completed in its final version.

3 Summarized results

3.1 Paper version of the checklist for inspections of the building and related plant systems

According to the worksteps described in chapter 2.3 the funded project got started by compiling a paper version of the inspection checklist. In distinction to the electronic version, the paper version also considers 2 phases of work, which

go beyond the building inspection proper, namely: preparatory work and follow-up work

Additionally, many pieces of fundamental information were included (like tables for determining surface areas and volumes, explanations concerning various issues like zoning or determination of a ballast unit, sketches, and notes on DIN V 18599 default values), all of which were compiled in 7 annexes. The complete paper version of the checklist is contained in annex 1 of the final report.

3.2   Electronic version

Contrary to the paper version, the electronic version exclusively represents the building inspection proper. It is aimed to obtain a complete documentation of the building with regard to the input data required for DIN V 18599 software. It is a well-known fact, however, that a building inspection will sometimes fail to supply all required data. An example for this situation is the determination of U-values for the building components. Usually, these values are identified from planning documents or from drillings through the building component, or one refers to rule-of-thumb values used by the body issuing the building energy certificate or to the building age categories given in the BMVBS-guidelines. Here, the checklist offers two options: (1) the direct allocation of a U-value to a building component (if known), (2) a description of the identifiable constructions, the component size, addition of a photograph to document the component (if value is unknown).

The checklist is started by "setup.exe". Subsequently, the programme is automatically installed on the computer in the directory "Fraunhofer-Institut fuer Bauphysik/Elektronische Checkliste". The programme gets started in the start menu under "Fraunhofer-Institut fuer Bauphysik/ Elektronische Checkliste". Then the following screen will appear:

Fig. 1: Start window of the electronic checklist for buildings and related plant systems (non-residential buildings)

The user interface has been subdivided into three areas, see Fig. 2:

- the tree structure designed for navigation through the various input fields (left-hand, marked red in the illustration)

- the actual input field for all characteristic values and descriptions (centre, marked green in the illustration)

- an information field with additional information about the input fields (right-hand, marked blue in the illustration)
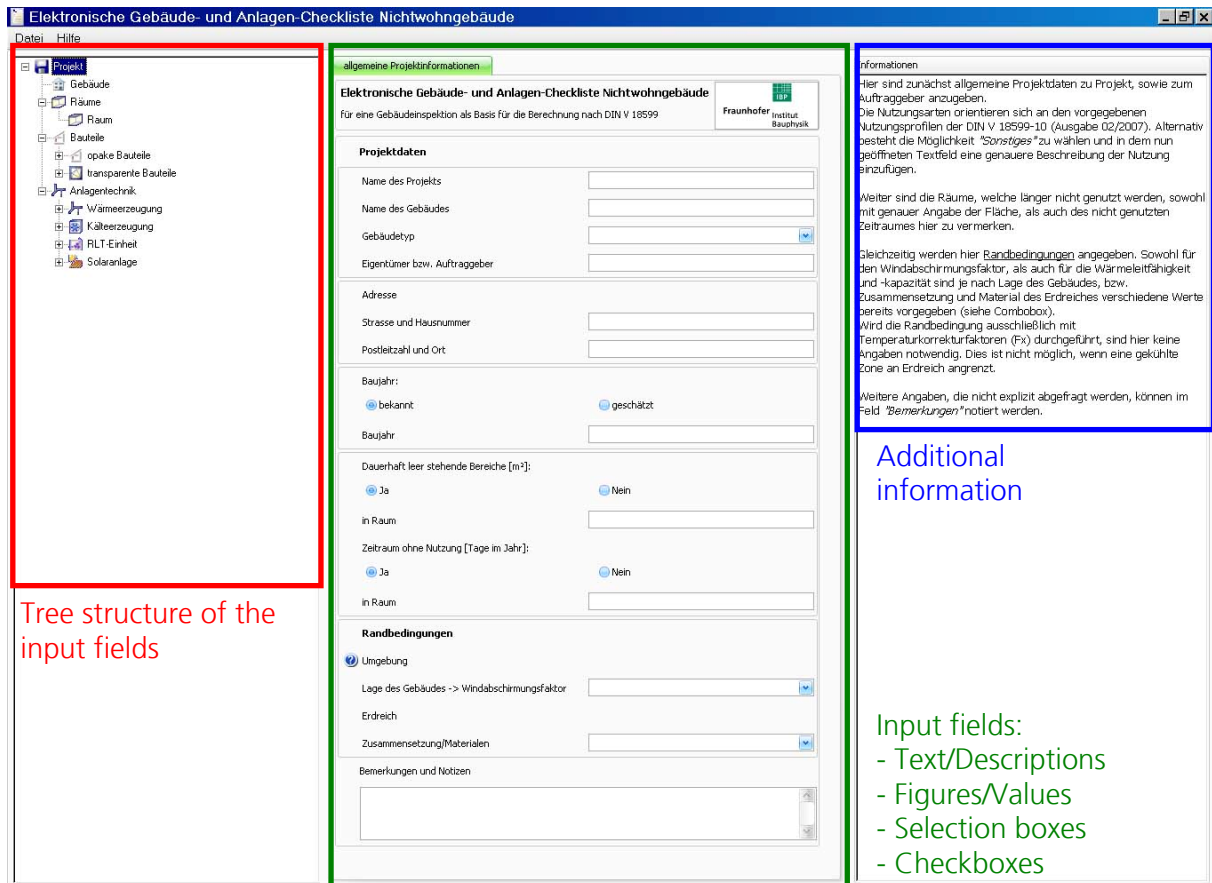

Fig. 2: Sections of the user interface displayed in the tool "Electronic checklist for buildings and related plant systems - non-residential buildings".

Navigation through the various input areas is done by clicking on the tree structure. To begin with, the following main areas are displayed:

- Project: general information on the project, year of construction, unoccupied sections, boundary conditions of the surroundings, etc.

- Building: Information obtained by examining the building from the outside

- Rooms: Information gained by analysing the spaces, like zoning/ utilization, lighting areas, internal heat sources, colours of the building component surfaces, type of the enclosing building components, radiators, lighting system, identifiable ventilation systems, etc.

- Building components: Information about transparent building components and opaque components (walls, bottom limit and upper building limit)

- Plant systems: in the different categories
  - heat generation (heat generators, distribution/ pump, storage),
  - cold production (cold production, pumps),
  - AC/ ventilation unit and
  - solar plant or PV system
  information about the production and distribution of heat, domestic hot water, cooling and ventilation can be given. The emission/ transfer systems were placed in the area of the 'space' input because they can be examined right there when inspecting the building.

There are different types of input fields. Firstly, there are description fields that are intended for the input of names or designations, types or descriptions. These descriptions are also used if the actually required parameters cannot be determined during the on-site inspection (for example, the U-value of a wall). If this value cannot be established during the building inspection, the wall construction (individual layers if identifiable, wall thickness, further details) can be recorded in the building protocol. On the basis of this data it will later be possible to calculate the U-value or to determine it according to the BMVBS guideline (depending on the year of construction).

Other parameters can only be entered as numbers (like the year of construction), areas, air volumes, etc. In these cases, the programme will only accept the input of digits.

Finally, the selection boxes present the last type of input. Here, the programme suggests a choice and the user must choose one of the options. Depending on the selection made, further input fields may appear. Again, the U-value of a building component is presented as a simple example. At first, the user is asked whether or not the U-value of a particular building component is known. If the answer "yes" was chosen, an input box for the U-value will appear. A slightly different form of a select field is the prompt "type of building", which permits to choose from among a list giving "office building", "school/ nursery school", "church/ community centre" etc.

The programme supports to the user in three ways. Firstly, there is the general information on the application of the programme that can be found in the tool bar under "Hilfe/ Help", then "Kurzanleitung/ Quick guide". Here, the individual features (like the tree structure and how to add more input areas or delete them again), the information bar on the right hand and the short information for the "flyover" across the blue question marks are summarized.

The information box in the right-hand bar provides extensive information on how to determine the required parameters in the central input field. For

example, reference is made to default values contained in DIN V 18599; also, continuative definitions (of different types of glazing, for instance) are listed.

The 🔵- fields in the central input zone conceal short information texts referring to the respective parameter, which can be displayed via "flyover" by using the mouse.

In many input fields, more than just one module is required. An example for this situation is the module "Building components/ opaque components/ wall components". In most cases, a building construction consists of more than just one type of wall. In addition to the external walls, also doors and internal walls that are adjacent to unheated zones can be entered. By clicking the right-hand mouse button on the main directory "Wall components", additional wall types can be generated or deleted. When there are several modules within one main directory, the main directory input box will automatically create a tabular survey of the various types. In the wall components example, for instance, a table will be created under "Wall components", which compiles the number, type, and the U-value (if given) of the building components. A similar procedure is offered in the area of heat generators and rooms.

The original function of the electronic checklist is to facilitate the input/ collection of data during the building inspection, but it can also be used to compile a documentation of the building. For this purpose, it is possible to upload graphics files (like JPG-files) in the appropriate input fields ("Images").

Subsequent to the parameter input, the programme offers to check the input data for completeness. Uncompleted input fields are marked in the tree structure and in the respective input boxes with a 🔴 sign, so as to be completed by the user. The check option is found in the menu bar under "Hilfe/ Help".

The queries and the completed input fields can be printed at any time. For printing, first select "Datei/ File", then "Drucken/ Print" in the menu bar. It is possible to print the entire building survey or just some selected areas (pages).

The tool is available as a download on the homepage of Fraunhofer Institute for Building Physics IBP (www.ibp.fraunhofer.de/wt). Prior to downloading, interested users are asked to give some basic personal data, which will be treated strictly confidentially.