Research Project energy:base

Conceptual Development of a Technical Platform for Buildings with Low Energy Consumption

Abridged Report

Completion: March 31, 2008
Research Initiative: “ZukunftBau” ('Future Building')

Abridged Report

Part of the “ZukunftBAU” research initiative of the Federal Ministry of Transport, Building and Urban Affairs (BMVBS) and the Federal Ministry for Building and Regional Planning (BBR) and on the occasion of the participation of the Institute for Design and Energy-Efficient Building (ee), Faculty of Architecture, at the Technical University of Darmstadt (TUD) in the international student competition Solar Decathlon 2007.

The research report was financed by funding from the Federal Ministry for Building and Regional Planning.
(Ref. No: Z6 – 10.08.18.7 – 06.22/II2 – F20-06-016)

The author is responsible for the content of the report.

Written by

Faculty of Architecture
Institute of Design and Energy-Efficient Building
Prof. Manfred Hegger
Dipl.-Ing. M. Sc. Econ

El-Lissitzky-Strasse 1
64287 Darmstadt
Tel +49 6151 16 2046
Fax +49 6151 16 5247
www.ee.tu-darmstadt.de

Compiled by
Prof. Dipl.-Ing. M. Sc. Econ. Manfred Hegger (hg)
Dipl.-Ing. Michael Eichmann
Dr.-Ing. Thilo Koch
Dipl.-Ing. Isabell Schäfer
cand. arch. Andreas Kinkeldey
Contents

Research Project energy:base 1
Research Initiative: ZukunftBau ('Future Building') 2
Abridged Report 2
1  Research assignment: energy:base 4
   1.1  Initial Situation 4
   1.2  Aims 4
   1.3  Completion 4
2  Content of the Project 5
   2.1  Platform strategies and development of a system catalogue 5
   2.2  Examination of system modules 7
   2.3  Platform components, DIN regulations, geometries 7
   2.4  Development and proposal of a platform 9
   2.5  Modularisation and standardisation 9
   2.6  Platform location and integration 10
   2.7  User interface 11
   2.8  Example: 'Solar Decathlon 2007' 12
3  Summary and Outlook 14
1 Research assignment: energy:base

Conceptual development of a technical platform for buildings with low energy consumption

1.1 Initial Situation

Energy-efficient building places increased demands on a building's technical facilities, including the integration of technical systems in the building and the intelligent control and regulation of these systems.
These requirements often meet with insufficient planning skills and a piecemeal construction industry, largely comprising unskilled labourers.
The constant shortening of construction and planning periods increases the pressure to simplify planning and design specification processes and to support their rapid practical implementation.

1.2 Aims

The aim is the conceptual development of a technical platform, which is initially to be available for residential buildings. Particular emphasis is placed on creating a building with low energy consumption, which requires the optimisation of the building's technical components, in terms of both their performance and size.

The merging of components onto a single platform, to which external components can be connected, is done on a modular basis. This results in a considerable simplification and structural clarity of the building's technical facilities.

The standardisation of components results in a high level of flexibility as regards their composition. The possibility of integrating them in various rooms, including the kitchen or bathroom, creates the additional benefit that it is a space-saving solution, since it does not require a special room for housing technical equipment; it also allows easy access to the technical systems.

1.3 Completion

This research project ends in March 2008.
2 Content of the Project

To develop the ‘energybase’ platform for residential buildings, the presented findings were devised on a conceptual level, in accordance with the following steps:

- Platform strategies and development of a system catalogue
- Examination of system modules
- Platform components, DIN regulations, geometries
- Development and proposal of a platform
- Modularisation and standardisation of modules
- Platform location and integration
- User interface
- Example application: ‘Solar Decathlon 2007’ House, by the TU Darmstadt

2.1 Platform strategies and development of a system catalogue

The first step was to conduct an analysis of the platform strategies generally applied in industry. The system of a platform strategy, whereby a variety of models are developed rationally from platforms and additional modules, was transformed in principle to the technical platform for buildings. The platform constitutes a merger of components jointly required for a variety of systems. The platform can be combined with alternatively selectable, active systems (non-platform elements). The various combinations enable the implementation of various energy standards for buildings.

![Graphical representation of the transformation of the platform strategy from the automobile industry onto a technical platform for buildings. Source: FG ee](image-url)
Drawing up a catalogue of technical systems serves to provide an overview of possible combinations, bearing in mind the great variety of active and passive systems, and is also the basis and foundation of the present development of a technical platform. Here, the possible, alternative active and passive systems have been presented with respect to the appropriate energy standards that can be attained.

Ill. 2: Overview of possible alternative systems with respect to the appropriate energy standard. Source: FG ee
2.2 Examination of system modules

To be able to render statements as to which technical components and schematic diagrams should be taken into consideration in the conceptual design and development of the platform, the various technical building systems were analysed. Components, pipes, hydraulic connections, and the internal and external connections and individual components were examined for the frequency of their occurrence. A graphical superimposition of the schematic diagrams was drawn up in accordance with the frequency of occurrence of hydraulic connections. By using this approach, the connections to be taken into account for the platform development could be analysed and presented.

![Graphical superimposition of all connection lines included in the examined technical building systems](image)

Ill. 3: Graphical superimposition of all connection lines included in the examined technical building systems, Source: FG ee

2.3 Platform components, DIN regulations, geometries

After analysing the technical systems and their components and connections, the possible platform components were determined, along with their connections and geometries and the regulations and DIN provisions to be complied with. On this basis, it was possible to devise the structure of the platform. The platform constitutes a merger of hot water tank, pump groups, valves, solar station, and control devices. Hydraulic connections for water, heat circuits, solar thermal power, and other integrable equipment are provided for. Other equipment can include the combination of up to two heat generators and a further energy storage unit.
Ill. 4: Graphical representation of the platform structure, including platform components, hydraulic connections, and additional devices. Source: FG e
2.4 Development and proposal of a platform

On the basis of the developed platform structure, a schematic diagram and possible example platform structure was devised. The result was the development of a simple and compact platform architecture that is able to incorporate the determined platform components. The desired ability to create a variety of combinations was rendered possible using standardised, commercially available, flexible connectors.

Ill. 5: Representation of the geometric implementation of the platform housing and platform components.
Source: FG ee

2.5 Modularisation and standardisation

In line with the aim of simplification, both platform and equipment are placed in reference with a standard measuring system. This increases the flexibility of the platform with respect to the possible composition of the general system of technical building facilities. With regard to the possibility of integrating the platform into the general layout of the apartment, the measuring system selected was that which is in general used in the market for technical household appliances. The platform and integrable equipment were merged in housings created in line with the measuring system. The result of this was the development of a flexible and integrable modular system.
2.6 Platform location and integration

The increasingly compact nature of technical building facilities and the consequent minimisation of their space requirements reduces their dependency on special equipment rooms. The platform system developed here is intended to offer the possibility in future of integrating equipment in an aesthetically appealing manner, within the general layout of the apartment. This integration not only results in an increase in available space but also allows a high degree of visibility and control. The platform can be integrated in various locations, such as the kitchen, bathroom, or cloakroom. However, as a result of its high degree of use, the kitchen presents itself as a suitable location, also due its central location within the apartment. Furthermore, it represents an economic solution, since the majority of connections and utility shafts will already be present there. The possible integration of the platform in a domestic kitchen is presented as an example of a case with the most difficult design requirements.
2.7 User interface

In order to enable optimum control and regulation of both the platform and the integrable equipment, as well enabling and even improving communication with the user, a virtual platform is to be added to the physical platform. This virtual platform is to be developed as a user interface. A touch screen incorporated in the front of the platform serves as a communication interface. The interface is intuitive and easy to operate. Inputted data and information received from sensors within the building are processed in an underlying building zone model and passed on to the individual components via the energy manager, by means of appropriate control commands.

The interface was developed in such a way as to allow settings to be performed on two levels. In level 1, the basic permanent settings are made by the installation technician; this level is password-protected. In level 2, the user himself is able to make corrective alterations to the settings, in accordance with suggestions communicated in the information display regarding current energy consumption, energy saving possibilities, and operating statuses. There is also a special function, in which savings potential, and current and forecast consumption are displayed, based on current energy costs, in monetary terms (euros). Various user interface scenarios are illustrated as examples.
2.8 Example: 'Solar Decathlon 2007'

The Solar Decathlon House ('SD-House'), the entry of the TU Darmstadt in the Solar Decathlon 2007 competition, is a highly energy-efficient building, with a complex and comprehensive system of technical building facilities, which makes it a good example of the integration of the 'energybase' system. To demonstrate the possibility of integration, the basic underlying energy concept, the planned active systems, and a further development are presented on the basis of the platform.

Ill. 8: User interface: example of an interface scenario. Source: FG ee

Ill. 9: 'SD House' (elevation). Source: FG ee
The 'energybase' platform that has been developed here can serve as a replacement of the compact ventilation system installed in the SD House. The platform is combined with a cross-flow heat exchanger, a reversible heat pump as a heat generator and the installed active systems.

As a concrete example, another advantage of the platform, in addition to its more compact dimensions in comparison with the compact ventilation system, is the ability to integrate it into the house's kitchen, in turn resulting in a space gain. The former equipment room would now be available as an additional utility area.
3 Summary and Outlook

The findings of the research project have shown that the development of a platform system for a building’s technical facilities is not only possible but also makes sense. The standardised, compact and flexible modular system that has been developed offers numerous advantages compared with standard systems, in terms of manufacture, assembly, flexibility, and integration.

The implementation of component and connection uniformity across all manufacturers will stimulate competition and support the continued development of both technical system components and their standardisation. On an international level, this can lead to a strengthening of competitiveness throughout the German building and component industries.

Moreover, the development of the platform will have considerable benefits in the areas of planning, practical implementation, and maintenance. The economic advantages and potentials of the platform in such areas as manufacturing, marketing and flexibility should act as incentives for producers, investors and industry to spur on the development of the respective equipment structures. The simplifications in planning and constructional procedures appeal directly to the target groups of planners, construction engineers, tradesmen and users. The increased level of property investment can be offset not only by the simplified and faster assembly procedure, which in turn shortens construction times, but also by the reduced operating, maintenance and repair costs.

Altogether, the standardisation of technical facilities for buildings and an improvement in their energy efficiency could secure a higher level of energy for future building projects. The 'energybase' project is initially focussing on the construction of new houses and residential buildings with low energy requirements. In order to pursue developments and considerations, the construction of a prototype should be carried out in a follow-up project. This would advance the development and result in a practicable use of the platform.

As for the question of the extent to which the platform can be employed in other types of apartment and buildings, this must be tested in further steps. The platform may well again prove to be an efficient system in terms of energy and economy, resulting in benefits and savings.