Low-energy concepts for office buildings

J. Kahl, J.-P. Kerstens, J. Lehmann
J. Kahl, J. P. Kerstens, PAS – Podium for Architectural Studies,
Kronenstr. 30, D-7500 Karlsruhe, Germany,
Leidsegracht 103 A, NL-1017 ND Amsterdam, Netherlands
J. Lehmann, Uni Karlsruhe, D-7500 Karlsruhe, Germany

The large number of innovative energy concepts which have been elaborated today to the stage of practicability open up new opportunities for contemporary architectural design.
Energy concepts which pursue the aim of making optimum use of every available energy potential make the building itself an essential component of the basic energy logistics. This is the precondition for an extended concept of integral planning which includes the architectural design in the interplay of all energy-related components.
The systematic elaboration of this potential of the building and its building components, as worked out by PAS in several design projects, prove the possibilities of realising low-energy office buildings with energy loads for cooling and heating not exceeding those of recent low-energy housing projects.

1. INTEGRAL PLANNING

The traditional idea that a building which is hermetically sealed off from its environment and which has a perfect system of control engineering is the only kind of building at all which can operate and work can be replaced today by the idea of subtle "low-tech" approaches comprising small parts which are capable of recognising inter- dependencies and integrating the diverse individual elements with their relation to their context to form a concept which can be controlled dynamically and individually. Architecture can permit one to experience technical mechanisms so as to extend the quality of residential and work areas by an essential dimension.
The process of designing a building is integrated into a fabric of diverse dependencies and interactions which is characterised by breaches and contradictions, priorities and contradictory demands. Architectural handling of this complexity is focus of the work of the Podium for Architectural Studies.

For this purpose, a new form if organisation for the planning process has been created with PAS. It operates as an innovative nucleus which can respond flexibly to new challenges in an interrelated team of project-related

specialist disciplines within the framework of a cooperation model. Continual transfer of knowledge leads to the establishment of subject-specific findings which are further-developed to form integral concepts. The new concepts are then followed up in greater depth by accompanying research, system development and public relations work, by modern project scheduling and experimental planning and construction.

Architecture as a holistic concept thus performs the role of coordinating and integrating the complex factors which influence the building. During the last two years, the Podium for Architectural Studies has worked in-depth on the development of innovative climatic and energy concepts in close cooperation with the scientists of the Technical Building Management Faculty of Karlsruhe University and in cooperation with other specialist disciplines, such as acoustic design, workplace ergonomics, product development, ecology and building economics.
On the basis of typology studies and dynamic computer simulation models, it was possible to develop integrated climatic and architectural concepts for large-scale, naturally ventilated, low-energy office buildings which meet the complex demands applicable to an intelligent and modern building.
The dynamic load calculations for energy-based simulation of a building which are becoming ever-more complex and reliable take the place of a "trial and error" approach. This means that, even at a very early point, it is possible to submit qualified and verifiable data on the mechanism and efficiency of climatic and energy concepts.

Architecture, encouraged by the new capabilities of innovative energy engineering, can assume a new role in the complex planning processes if the aim is to find modern, architectural answers to the diverse requirements resulting from human needs, environment aspects and social questions.
The three categories of **environment, society and human needs** play an essential role in this.
The environment, understood as the context in the broadest sense, means the whole situation into which the building is placed. Consequently however, nature and its basic elements may also be the context for a building or, to be more precise, so too may be the landscape or the town or city through to the direct surrounding area. Light, wind, air, water are always dynamic parts in the environment buildings.
This question of the building allows one to experience this context, utilises what is available and turns it into new quality.
The term society poses the question as to contemporary, modern architecture. What does architecture have to say about the phenomena of our living together and how does it reflect this?
The term human needs poses the question as to what the user needs of his working environment. Since the workplace generally cannot be freely selected, the architectural design assumes responsibility for man`s physical, social and physical well-being.

So we are dealing with an analog approach of the phenomena of environment, society and human needs. This results in new architectural aesthetics of the space-time criteria of society and environment.
Even though architecture formerly centred around man, it is now the case that phenomena such as daily rhythm, urban spatial structures, infrastructures and environment elements (air, wind, water, soil and the sun) are integrated in the design as equal-ranking elements.

Architecture is capable of responding adequately to each of the three phenomena with the means of dual reference, whereby the building components are understood both as a part of the energy system and as an area which one can experience, and holographic density, which allows one to experience the diverse qualities of an architecture not additively, i.e. spatially adjacent, but at each point and in each component of the building simultaneously. We shall illustrate the use of these means by way of example of the following project.

2. THE BREATHING HIGH-RISE BUILDING

is a design for the Innovation Centre in Karlsruhe, Germany (competition by Philip Holzmann AG, designed in cooperation with the Office Group 4+, 2nd prize), which made it possible to develop a naturally ventilated, low-energy office building.
The central question for this design was to develop a building organism for this new content which reflects the intangible and procedural character of new technologies by the buildings' own function and own aesthetics.
To this aim, the tectonically tangible elements of the building were withdrawn in favour of a building composition incorporating only three-large scale building components: the **climatic envelope, the plenum and the office wings.**
It is crucial that each of these components have, at one and the same time, both a climatic-energy mechanism and an aesthetic-architectural mechanism.The building can thus be experienced as "intelligent low-tech organism" both inside the building and from a great distance away.The office wings act both climatically and aesthetically as a "passive mass" whilst the climatic envelope in front is "regulative", i.e. active. The climatic envelope (78 x 78 m) is like a giant screen which is characterised by a dynamic composition of surfaces and bodies which changes as a function of time: The bodies and surfaces appear to hover or float in the plenum. The plenum creates the effect of depth. From a greater distance however, the same effect of depth is being reinforced by the apparent hovering and floating of the surfaces behind the screen.

3.2 Plenum

The plenum is a large air-filled space which extends over the entire height of the building. It is bounded by the climatic envelope and the walls of the office wings which are designed as an interior facade. The air-filled space represents an intermediate climate between outside climate and interior climate.
The plenum serves:

- as a climatic buffer
- to generate heat in the winter, utilising the greenhouse effect
- to cool in the summer by nighttime cooling and, by its storage function, to emit the heat at a later point
- as an air-filled volume for natural intake and extract ventilation of the office storeys
- as an intermediate zone creating a novel quality of usage
- as an area for controlling the artificial working environment

3.3 The Office Wing

The office wing accommodates the office storeys. It is sealed off from the outside climate and is delimited with respect to the plenum by interior facades which can be opened either fully or partly.
A solid and largely non-faced design serves to increase the storage capacity. Arranging the north-facing facades as a "Bande Active" permits vertical pipe and cable ducting in order to avoid suspended ceilings and false floors.

4. PASSIVE UTILISATION OF ENERGY

Two single-glazed glass pane elements provide the fundamental principle of double thermopane glazing with a large air space. The temperatures are regulated dynamically by means of the air-flap ducting system to provide an "active" window.
The combination of climatic envelope and plenum is a hybrid form of "chest-freezer" for optimising the buffer effect and the so-called "supply/return atrium" for optimising natural ventilation. It provides thermal and visual cosiness both for "cold winter days" by protecting against the cold outside, utilising insolation energy to the full and transferring this energy to the interior spaces and for "hot summer days" by providing adequate protection mechanisms against overheating and ensuring largely natural cooling of the building by means of a central control system.
During the transitional periods, it is possible to achieve a situation in which the base temperature is at a high level so as to dispense with the need for additional heating.

Energy costs are minimised in the wintertime owing to the fact that there is little need for heating.
Attaching ceramic structures to the surface of the panes, trapping the radiation between the two panes and fitting transparent heat-absorbing glass have made it possible to absorb the high-energy light radiation and convert it to heat which is either supplied to the plenum or dissipated into the open air, dependent upon demand and control of the air flaps. The office areas are ventilated (intake air) and vented (outgoing air) naturally. Nighttime ventilation ensures that the plenum and office element are cooled in the summertime.

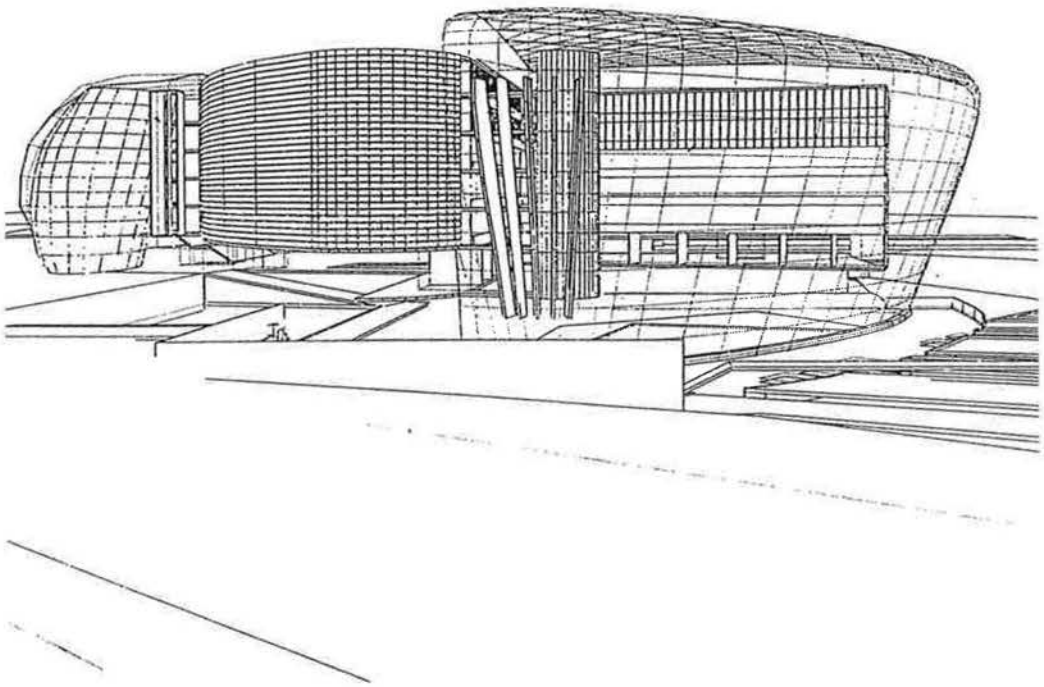
5. ACTIVE UTILISATION OF ENERGY

Sunshading in the form of slatted shutters and prism systems which guide daylight into the office areas and reflect the thermal radiation. The slatted shutters are controlled with daylight sensors. The position of the slatted shutters prevents them from becoming soiled.
A distinction is made between standard equipment and retrofitting. The standard equipment is closely linked to the building typology. The innovative character lies in the passive utilisation of solar energy and in the addition of future-orientated technology.The standard equipment comprises only tried-and-tested technology:

- Double glazing
- Slatted shutters for regulating the light and for avoiding extreme temperature (shading in the summertime and thermal insulation in the winter).
- The northerly offices are connected to the plenum via a ventilation system.
- Light regulation in the roof.

6. RETROFITTING AND PRECONDITIONS

Retrofitting permits the use of ultra-modern technology components and experimental technology:
-Silicon solar-cell coating of the inside of the front glass layer for generating electrical power and using this electrical power directly for cooling by regenerative energy, e.g. in the conference areas.
-Special elements for controlling scattering or concentration and guidance of the daylight. The facade can accommodate elements which scatter the daylight in order to brighten the plenum and elements to deflect zenithlight and the direct sunlight to the ceiling areas of the office storeys. Appropriate design of the underside of the ceilings achieves illumination extending to the depths of the rooms and areas.
-Capabilities for experimental trials in the sector of solar energy research.



Design for the environmental protection office, Karlsruhe

It has yet been possible to work out a series of office building designs on the basis of the Breathing High-rise research. In the design for an environmental protection office in Karlsruhe for instance, the theme of integrating landscape and natural resources was combined with a building type offering three atria. The climatic an architectonic functioning of the atria has been worked out in relation to orientation.