Energy efficient private service buildings with “ecofacility”: comprehensive support for building developers

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Abstract
The current approach to the design of modern office buildings is dominated by glazed façades and comprehensive building installations such as air conditioning systems to achieve proper indoor working conditions. This, however, leads to high energy consumption and, subsequently, high energy costs. Furthermore, the resultant high maintenance efforts for installations lead to increased operating costs.

In the upcoming months, building developers will be confronted with the national implementation of the Energy Performance of Buildings Directive. In future, minimum requirements on the overall energy efficiency of buildings will be mandatory and the energy demand of a building will be an additional factor of competition due to the energy certificate.

The integrated energy design process supports building developers in order to face both requirements: developing cost effective and energy efficient buildings. The service for building developers is based on a modular concept to give support in every planning and construction phase: In the first planning stages, this process contains activities such as the definition of criteria regarding energy efficiency, assessment of draft, calculations of heating and cooling demands and suggestions for improvements. During the detailed design phase, assessments with the help of simulations of energy performance and life-cycle costs calculations are carried out. Quality assurance during the construction phase with newly developed warranty models completes the process.

Since the summer of 2006, ecofacility – the Austrian climate protection programme for energy efficient private service buildings – offers these consulting services and aims to support building developers during all design stages in putting the integrated energy design approach into practice.

Introduction
Newly built service buildings – such as office buildings, shops, hotels or schools – with a final energy consumption exceeding 400 kWh/m²/yr are still common. However, several examples exist which prove that service buildings with a final energy consumption of less than 40 kWh/m²/yr are equally feasible (ecofacility 2006).

What is the reason for this considerable disparity in energy consumption levels? Although the use of innovative technologies certainly plays an important role, an even more decisive factor is the choice of an integrated design approach. An approach that focuses not only on the appearance and functionality of the building, but also accounts for its energy performance during the utilisation period. Decisions made at an early design stage of new buildings, such as those concerning the shape and orientation of a building, have a crucial impact on the building’s future energy consumption (Energieagentur Nordrhein-Westfalen 2004). Only an integrated design process at this early stage allows for optimisation in as many areas as possible (architecture, function, building code, comfort, investment costs and operating costs). For a timely identification of areas for possible improvements, a regular assessment of the draft according to certain criteria becomes necessary at the end of every planning stage. At the first design stage – the predesign stage – the main assessment criterion is the net en-

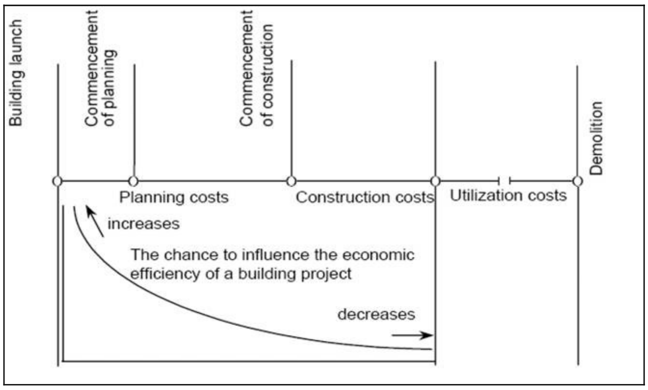

Figure 1: Chance to influence the economic efficiency of a building (Source: Bundesamt für Bauwesen und Raumordnung 2001)

ergy demand; later – when the installations have been chosen – the final energy demand becomes relevant. Additionally, an analysis of total investment and running costs is possible with the help of a life-cycle cost estimation.

Concerning life-cycle costs, it is widely recognised that 80 % of operating, maintenance and repair costs of a building are already determined during the first 20 % of the entire planning process – i.e. during the predesign and design stage (European Commission 2003, see Figure 1). In the subsequent stages, the chance to lower these costs decreases.

The same concept applies to the energy demand of a building: the earlier the energy demand of the building is taken into account and optimised during the design stage, the bigger the chances for success. Due to the fact that at this stage of the design process the amount of time and money invested is still relatively low, redesign is still feasible and financially insignificant. An integrated energy design process and regular assessment provide the basis for a quick and efficient completion of the project, less construction defects and lower repair costs – and therefore help maintaining low investment and repair costs (Voss 2006).

In the course of implementing the Energy Performance of Buildings Directive (EPBD) on a national level, every member state incorporates minimum standards for the energy performance of buildings in their national building codes. As soon as the implementation process is completed, new buildings as well as existing buildings that are subject to major renovation will have to comply with certain thermal and energy performance criteria. Thus, building developers have to take low energy demand for buildings into account in future.

How can the construction of an energy efficient building be realised? How can real estate developers be supported to fulfil the requirements of national implementation of EPBD? How can the theoretical concepts of integrated energy design, life-cycle cost analysis and optimisation of thermal and energy performance of new buildings be put into practice and become part of the standardised construction process of building developers? How can clients make sure – especially at the project initiation stage and during predesign – that an energy efficient service building is built in the end?

ecofacility is a programme of the Austrian Climate Protection Initiative "klima:aktiv" and aims at increasing energy efficiency in private service buildings. Recently, ecofacility has developed a standardised consulting process for new private service buildings. The ecofacility consulting services help building developers to incorporate energy efficiency as a key factor into the planning process right from the beginning. The aim is to design buildings that can operate with minimal energy consumption, i.e. with minimal heating and cooling demand. The better the building envelope is adapted to climatic conditions and the function of the building, the lower the energy demand (Hausladen 2005). The choice of installations should be based on the estimated energy demand. This way, it is guaranteed that the installations fit the building and that investment costs are not increased by the installation of unnecessary and oversized equipment. In addition, indoor environmental quality must not be neglected; simple measures such as allowing for individual indoor temperature regulation by opening the windows raise the comfort level of the building occupants.

ecofacility applies this consulting process for private service buildings. However, this approach could also be applied for other types of buidlings as well.

ecofacility consulting services for building developers

Amongst others, ecofacility established a network of independent energy consultants as multiplicators for energy efficiency. The consultents attended a six days workshop to learn about different renovation models, optimise energy efficiency of buildings and the standardised consulting procedure. The programme provides a central contact point for co-ordination and quality assurance. Different schemes of subsidies for the consultancy service are provided.

The ecofacility consultants carry out consulting activities at building owners and developer and make sure that the future energy demand of a building is taken into account at every planning stage – from the first draft to detailed design – and especially at the early design stage. The best results can be achieved when the consulting activities take place within the framework of an integrated energy design process under independent guidance. However, the consultation is based on a modular concept so that the right service can be provided at every stage of the process.

DEFINITION OF GOALS

At the beginning of the whole design process, it is necessary to determine the energy criteria the building has to meet during the utilisation period.

At the beginning of the design stage of a building project, the client usually has only a rather vague and general idea of his objectives. Therefore, it is essential to translate the client's vaguely stated wishes and goals (strategic goals) into clear and measurable requirements (Von Both 2004, Hofer 2006d). These requirements form the basis of the entire design process and can be used in the design competition or the design bid (see Figure 2).

The requirements have to contain criteria, target values and indicators. They can be very general in nature and specify only maximum values of final or primary energy demand, or they can specify in detail maximum values of energy consumed by heating, cooling, lighting, etc. Some requirements even fix details such as minimal U-values for building components, obligatory installation of an exterior shading system, avoiding the installation of a chiller, etc. In addition to the requirements, an assessment method has to be defined which makes it possible to check at every design stage if the decisions made meet the requirements (Geissler, 2001). This specification of requirements combined with an assessment procedure makes it possible already at the initial planning stage to check the compliance with energy efficiency criteria.

At the beginning of the design stage, it is necessary to find out which innovative or energy efficient options are available for the building in question. The number of options is determined by some basic decisions concerning e.g. the location or shape of the building which have to be made or are already made when design activities start. If the location of the building has already been chosen, it can be determined whether e.g. the prevailing winds allow for a movable exterior shading system or the noise level allows for natural ventilation.

The development of comprehensive concepts and a closer look at different options often reveal conflicting goals. Finding an optimal solution which resolves these conflicts allows for significant energy savings, but only if this is done at a very early stage of the design process (Geissler 2002).

In addition, it is necessary to define which of the requirements are mandatory and which of them may still be changed in the course of the optimisation process (Geissler 2002, Bosch 2006). A list of questions which is discussed with the client in the first meeting assists this process of defining requirements (see Figure 3).

ASSESSMENT OF BUILDING ENERGY PERFORMANCE DURING PREDESIGN

During the predesign phase, the architectural concept is assessed with respect to the estimated energy consumption. Based on the first sketches and drafts, several observations are already possible: e.g. whether to reduce the glazed area of the façade and/or a shading system is necessary to lower the cooling demand or, consequently, the installation of a chiller is required. Afterwards, suggestions for improvements of the preliminary draft as regards thermal and energy properties are submitted that aim at a reduction of the total energy demand.

Improveing and optimising the orientation and size of glazed areas at the façade as well as the architectural concept and still ensuring optimal daylight conditions, the energy saving potential regarding the cooling demand is up to 50 %. Looking at these criteria, energy efficient aspects of building components are not relevant. In further steps the façade, interior finishing and the ventilation concept is taken into account. Starting from an optimised building concept in the first step, implementing effective sun shading devices and considering building elements with effective thermal mass could reduce the cooling demand up to 100 % so that there is no calculated cooling demand any more. Furthermore, improved heat proctection could decrease the heat demand typically up to 40 %. However, in this phase only first estimations can be elaborated, detailled assessments will be carried out later in the process.

This assessment of building energy performance is carried out with the help of two tools:

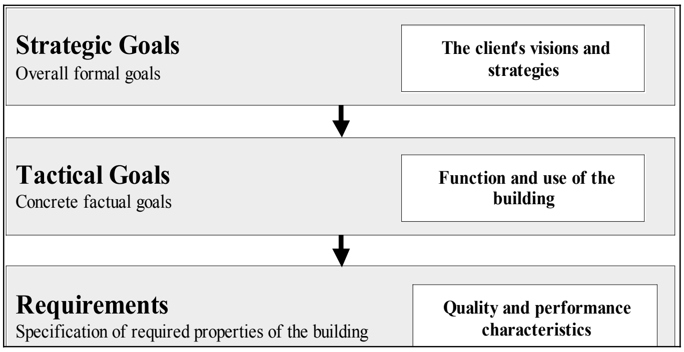

Figure 2: Process of defining requirements (Source: Von Both 2004)

- Calculation of the heat and cooling demand of the building: the net energy demand is calculated in order to determine whether an improvement of energy efficiency is advisable or not an absolute necessity.
- Qualitative analysis of the preliminary draft based on a standardised checklist: the checklist covers various aspects of energy efficient building practice. The draft is evaluated according to every aspect in the checklist, and – if necessary – suggestions for improvements are noted. The checklist covers the following aspects: shape of the building / architectural concept, orientation of the building / the sections of the façade, compactness of the building, number of internal rooms, effective thermal mass, thermal protection, thermal bridges, summer thermal protection (window-wall ratio, shading systems, orientation of the glazed façades), orientation of the office spaces, passive solar energy use, daylighting and ventilation. The online information site provided by ecofacility (http://tool.ecofacility.at) offers property developers and contractors an overview of the main aspects that determine the thermal and energy properties of the building.

The above two procedures are included in the ecofacility report on the preliminary draft which is presented to the client and serves as a basis for further detailed design of the building.

ASSESSMENT OF THERMAL AND ENERGY PROPERTIES DURING THE SCHEMATIC AND DETAILED DESIGN PHASE

During design development and detailed design, the ecofacility consulting services offer an in-depth analysis: An hourly simulation of the building's thermal and energy performance simulates possible realisations of the building and its installations, including internal and external influences and their synergies. These simulations help in spotting flaws in the design and make sure that the energy performance of the building and its in-

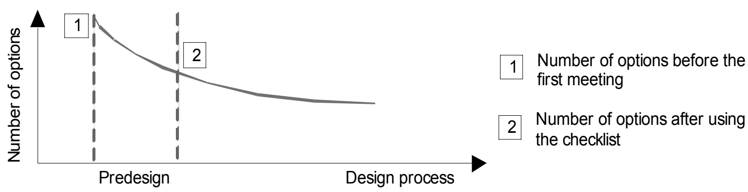

Figure 3: Reducing the number of options with the help of a checklist (Source: Austrian Energy Agency)

stallations are optimised. Based on the results of the different simulations, the estimated energy costs of the building can be calculated. For the calculation of the life-cycle costs, additional operating costs such as maintenance, repair and cleaning costs are estimated and, together with the energy costs, added to the investment costs.

GUARANTEE MODELS FOR THE OPERATIONAL PHASE

To ensure that the quality of the design process is entirely reflected in the construction and operation of the building, various guarantee models can be applied, depending on the project delivery method (single product contractor, general contractor, total contractor or integrated system provider). Similarly to Energy Performance Contracting projects, the guarantee models apply to energy costs / energy consumption and quality of realisation. The ecofacility consultations support clients with the integration of these guarantee elements into the contract.

Collaborations

In order to increase its know-how and thus continuously improve its services, ecofacility collaborates with several EU projects. In the framework of "Integrated Energy Design in Public Buildings" (INTEND), an "Intelligent Energy – Europe" project, several countries compare their processes for thermal and energy performance optimisation of service buildings, assess other concepts and develop common approaches. In the course of the EIE project KeepCool, the promotion-project of 'sustainable cooling' in the service building sector", extensive documents and checklists concerning summer comfort have been developed in the last few years which are now used in the consulting process.

Summary

The construction of a building with an optimised thermal and energy performance and an accordingly low energy demand does not necessarily require higher investment costs. The decisive factor is an interdisciplinary and foresighted – an Integrated Energy Design. Although this integrated approach prolongs the design process and increases the planning budget, in return the construction time and the subsequent costs such as energy and operating costs are significantly reduced. A qualitative (using checklists) and quantitative assessment (calculation of heating and cooling demand, building energy simulation) is essential for the identification of flaws in the design. In order to ensure the longevity of the quality of design beyond the realisation of the project, guarantee models can be applied. Thus, these new buildings can effortlessly meet the requirements soon to be implemented in the national building codes and are furthermore qualified for the upcoming energy certificate.

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