NACHHALTIG*wirtschaften*
konkret

FORSCHUNGSFORUM
4/2006

INNOVATION IN LARGE-SCALE RESIDENTIAL BUILDING CONSTRUCTION

DEMONSTRATION BUILDINGS WITHIN THE "BUILDING OF TOMORROW" SUBPROGRAM

bmvit
Austrian Federal Ministry for Transport,
Innovation and Technology

T O P I C

SUSTAINABLE CONSTRUCTION IN MULTI-FAMILY HOMES
IMPLEMENTATION OF PIONEERING CONCEPTS

Project inkl.wohnen/Wohnpark Sandgrubenweg

Project Mühlweg

In 1999, the Austrian Federal Ministry of Transport, Innovation and Technology (bmvit) launched the research and technology program "Sustainable Development", which aims to effectively support approaches towards sustainability in economic activities. Various research and development projects as well as demonstration and diffusion measures, which give new impetus to innovation in Austria's economy have since been supported within the scope of a number of subprograms.

The "Building Of Tomorrow" subprogram aims to develop marketable building components and concepts (for new construction and renovation) that meet the following criteria: Reduction of energy and materials input, promoting the use of renewable energy sources, using renewable and ecologically sound raw materials, taking into account social aspects, improving the quality of life as well as costs that are comparable to those of conventional building construction.

In Austria, one third of the consumption of raw materials and 57% of waste generated is caused by the construction industries. The development of strategies towards an efficient use of resources in this sector of the economy is of great importance. The improvement of resource-efficiency requires high-quality, technologically mature building concepts, which require low material input, produce little waste, ensure minimum of land consumption, long-term supply with renewable energy as well as operation of the building with a minimum of energy consumption. We need architectural concepts that guarantee a long service life and facilitate flexible use profiles of the building.

In Austria, sustainable building concepts, such as low-energy and passive house designs are relatively widespread in the field of one-family homes/new construction. In large-scale new construction (multi-family homes/multi-story buildings) and in the field of renovation, however, comprehensive experience with these innovative concepts is still scarce. Especially in publicly financed building construction with its special use profiles and cost restrictions, these new technologies have not yet seen a break-through on the market. The growing sector of multi-family homes/multi-story buildings in urban areas promises a great potential for the development of trend-setting building concepts that take into account new social, technological, and ecological developments. Also, innovative solutions in this field of building construction are of eminent importance for the dissemination of sustainable building designs in all fields of building construction. Especially projects where the costs of realization are comparable to those of conventional building concepts are apt to give decisive impetus to the further development and market penetration of these new technologies.

The sections below present **four demonstration projects within the "Building of Tomorrow" subprogram,** which have already been completed or are currently under construction. All projects involve multi-story buildings (three of them are publicly financed residential buildings) in urban environments. The buildings were newly built or renovated to meet passive or low-energy standards.

The construction projects use a great variety of innovative technologies in different areas as well as customized solutions developed for special purposes. The projects are based on integrated overall concepts, which resulted from a close cooperation between experts from research and practice. A great number of project partners were involved in the various planning processes. In all four projects, the sum total of innovative solutions for the various sub-systems yielded resource- and cost-efficient as well as high-quality and user-friendly results. Great care was taken to ensure continuous communication with future users – partly in the planning stages, already – and to provide for necessary information, advice, and various services after completion of the buildings. The projects will also provide for an evaluation of experience from the construction and use phases as well as for an outlook on further development in the future.

Project inkl.wohnen/Wohnpark Sandgrubenweg

RESIDENTIAL BUILDING AT UTENDORFGASSE 1140 VIENNA

Schöberl & Pöll OEG, Vienna

Using passive house technologies in public sector building construction

Project Utendorfgasse

■ This building project was based on research within the scope of the "Building of Tomorrow" subprogram, which addressed central issues concerning the introduction of passive house standards in publicly financed building construction. The results of this preparatory research were implemented and evaluated in this public sector passive house construction project, which is the first of its kind in Vienna. At the same time, **this demonstration project at Utendorfgasse is the first certified passive house development in Austria** (Certificate from the Passive House Institute Darmstadt, Germany). The crucial innovative aspect of the project consists in the fact that passive house standards are fulfilled at extremely low costs. This innovation was the result of an integral planning process, which involved seven engineering offices specializing in various disciplines. The use of dynamic, transdisciplinary simulation processes facilitated a holistic evaluation of the suitability of concepts for individual sub-systems (such as building design, ventilation, and heating system) with respect to the interaction of different parameters like occupancy, user behavior, climate, and possible failure of energy supply.

Building concept and building design:
The housing development consists of three five-story apartment buildings, which are all North-South oriented and have a total area of 2,985 m^2 usable floor space. The apartments have two, three or four rooms and feature generous glazing with balconies and loggias, which are thermally separated from the building. The apartment houses were executed in solid construction and are equipped with a permanently air- and wind-tight exterior envelope with highly efficient thermal insulation on all sides and without thermal bridges. The builders used slab construction (load-bearing apartment partition walls and ceilings). Great care was given to the thermal breaks at the bases of load-bearing walls.

Energy supply and technical equipment:
The heating system in passive houses relies on a ventilation system with highly efficient heat recovery. Basically, there are three different concepts for the ventilation of residential passive houses: local, central, and semi-central systems. A comparison of the different concepts has shown that, for the site at Utendorfgasse, a central ventilation system would be the best solution. Consequently, planners installed central units at the roof level of each building, which provide for central heat recovery, air filtering, support fans and electrical preheating units as anti-freeze device. In addition, each dwelling unit was equipped with local supplementary heating units as well as with continuous controls for airflow volume, which can be individually operated by the occupants. Heat generation for local supplementary heating units and for domestic hot water supply is effected by a central high-efficiency condensing boiler and a central hot water storage tank with circulation pump in each of the apartment blocks.

Costs:
The improved quality of the building envelope and the highly efficient ventilation system of passive houses cause higher initial costs. Optimization of building components, integrated simulation of performance and integrated planning for the project at Utendorfgasse made it possible to comply with the requirements applicable for publicly financed residential building construction, i.e. maximum costs of Euro 1,055/m^2 of usable floor space. Additional costs for the compliance with passive house standards amount to Euro 43/m^2 usable floor space.

Further research requirements:
Contrary to dynamic simulations and measurement schemes, the application of current national or international standards does not yield realistic results for low heating loads. What we need is a new approach to standards with accompanying science-based models. There is also further need for research and development concerning individual building components. For instance, there are no suitable acoustical windows for passive houses on the market that meet today's demanding sound proofing requirements. Especially in the low-cost plastic windows range profile dimensions are insufficient. Some benchmark results and specifications for standard apartment and front doors in multi-story residential buildings are missing. Therefore, it cannot be ascertained if passive house standards concerning air tightness can be fulfilled in the special conditions prevailing on account of pressure differences typically occurring in multi-story buildings.

PASSIVE HOUSE DATA (Calculation)

Project Utendorfgasse

- Heating energy: 14.49 kWh/(m^{2}a)
- Specific heat load: 9.13 W/m^2
- Overall primary energy consumption: 107 kWh/(m^{2}a)
- Air leakage n50: 0.18/h (apartment block 2)

TIMBER PASSIVE HOUSE MUEHLWEG 1210 VIENNA

BAI Bautraeger Austria Immobilien GmbH in cooperation with KLH Massivholz GmbH and Dietrich/Untertrifaller, architects, Vienna

Public sector multi-story building in massive timber construction built to passive house standards

■ The project goal consists in the development of an ecologically sound and sustainable design for residential building construction and in using it as a demonstration project. The building concept is based on four compact multi-story passive houses with a total of 70 dwelling units. The buildings use mixed construction; foundations and base-ment consist of concrete and the aboveground load-bearing structure uses boards made of 95% spruce and 5% fir. All the timber used in the project was supplied by Austrian companies.

Off-site prefabrication of load-bearing structure and facade elements:
In order to ensure adequate quality assurance it is advantageous to completely prefabricate as many building components as possible off-site; this is particularly true for passive houses. In addition, it is very important to take into account all fields of expertise involved, such as building physics (air-tightness, soundproofing, thermal insulation), structural engineering aspects, fire protection, assembly, transportation, etc. In this building project the whole structure of the outside wall (except the last layer of the plaster) including windows, French windows, and insulation had been prefabricated at the factory. The ceilings had also been prefabricated; only the flooring was completed on the site (after installation of plumbing, electricity, etc.). The very large elements result in an extremely short time for construction; the erection of one block with 18 dwelling units took less than two weeks to be rainproof. Industrial-scale prefabrication makes timber construction competitive compared with other designs, because it reduces costs and environmental impact (e.g. noise from the building site).

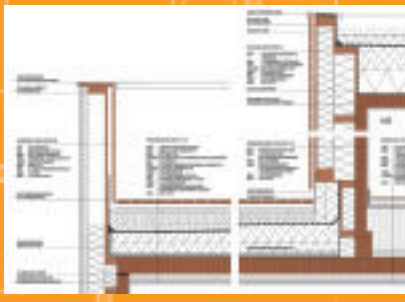
Wooden frame passive house windows:
Project participants tested various passive house windows on the market. The windows should meet the project goal (use of ecologically sustainable materials) as well as the demanding acoustical requirements of the Vienna Building Code. The building joiner Helmuth Stefan designed a modified wooden frame passive house window, which meets these requirements.

Special solutions for domestic technology:
Experience, especially in multi-story housing developments built to passive house standards, has shown two crucial weak points of typical heating / ventilation systems: the absence of separate temperature control for individual rooms as well as noise caused by incoming fresh air. The following measures aimed to solve these problems: The preheating unit in the fresh air duct was omitted and replaced by a supplementary water-based heating system (small radiators). Additional measures served to further reduce sound levels in the fresh air duct. Remaining heat requirements for space heating and domestic hot water supply are covered by means of a solar installation and a gas-fired condensing boiler.

Project Mühlweg

Quality assurance and user support:
It is planned that, one year after completion of the building, a quality assurance and evaluation process of the building and the technical equipment should be performed by experts who have not been directly involved in the planning and execution of the project. Information for tenants and support through the first year of occupancy as well as an evaluation of user experience will also form part of the process.

Facade Detail



Cross-section storys

PASSIVE HOUSE DATA
(Calculation)

- Heating energy: 13.1 kWh/m²a
- Specific heat load: 11.4 W/m²
- Overall primary energy consumption: 103.2 kWh/m²a
- Air leakage n50 (unfinished building): 0.2/h

P R O J E C T

INKL.WOHNEN – APARTMENT PARK SANDGRUBENWEG BREGENZ

Rhomberg Bau GmbH, Bregenz

Sustainable living space – generating added value for individuals and the community

Project inkl.wohnen/Wohnpark Sandgrubenweg

■ This project is based on the research paper "inkl.wohnen", which integrated existing knowledge from various disciplines to form a new concept for "sustainable living spaces". Experts from different disciplines such as architecture, urban planning, building biology, building ecology, and building physics, facility management, information and communication technologies, building services, mobility, organizational development as well as psychology and sociology closely cooperated in this project. The objective of this research consisted in the development of a holistic model for a multi-family housing development offering a range of additional high quality services. Another goal was to optimize the building concept with a view to life cycle costs in such a way that, in spite of improved service quality, there would be no additional costs for occupants. The pilot project "Apartment Park Sandgrubenweg" in Bregenz is a low-energy housing development with 60 to 80 owner-occupied apartments.

The highly flexible building concept, intelligent planning, and comprehensive communication will make it possible to create a **"home of one's own" in a large-scale housing development** and, at the same time, to pave the way for an environmentally and energetically sustainable use of the buildings.

The planners developed solution packages and implemented them in the pilot project:

Conscious planning:
The process of "conscious planning" provides buyers with professional support in designing the floor plan and the selection of materials. The goal is to carefully identify the buyer's individual needs and to ensure foresighted planning so that the living space will meet all the needs of the occupants in the future as well. A modular architectural concept and a flexible building design for multi-story residential buildings are prerequisites for the requisite room for maneuver.

Top quality architectural design – flexible and changeable:
Contrary to conventional building concepts for multi-story residential buildings, this project uses organizational and design structures that ensure a user-oriented concept for the floor plan and the interior. The overall concept relies on a cost-efficient, modular architectural design, which can meet occupants changing needs during all phases of life and which uses state of the art communication technologies and facilities in the building. Occupants will have the opportunity to create their individual home on their floor without interfering with esthetic overall design of the housing development. The modular floor plans provide for flexibility of use and facilitate future modifications, e.g. separating, opening up, or joining of individual dwelling units.

Environmentally sound building concept:
All building materials and components were subjected to a strict evaluation with a view to building biology and ecology as well as building physics.

The housing development conforms to low-energy standards; the energy-efficient heating and air conditioning systems use renewable energy sources. A central biomass (wood pellets) heating system supplies energy for space heating and domestic hot water.

High-tech in day-to-day life:
Advanced, but easy-to-use facilities and communication technologies are useful assistants in the "operation" of the dwelling units; these include "smart" control systems for heating, air conditioning, and shading, continual monitoring of current consumption and operating costs, modern alarm and security systems as well as access controls. A range of optional systems offers users the opportunity to select a customized high-tech package, which meets their own special needs.

Joint use of facilities and services:
In addition to the individualized dwelling units, the housing development will offer occupants the opportunity to take advantage of a number of services and facilities. These include innovative and use-ful services such as shopping service, laundry service, moving service, recreation rooms etc. as well as concepts for car sharing and flexible mobility.

Project inkl.wohnen/Wohnpark Sandgrubenweg

PROJECT

PROJECT 4

RENOVATION OF A RESIDENTIAL BUILDING AT MAKARTSTRASSE LINZ

GIWOG Gemeinnützige Industrie-Wohnungs-AG, Leonding

Project Makartstrasse

Renovation of a multi-story residential building to meet passive house standards

This project demonstrates sustainable and innovative solutions in the renovation of an existing large-scale residential building. The housing development with 50 dwelling units was built in 1957/58; within the "Building of Tomorrow" subprogram it has recently been modernized and renovated to meet passive house standards. Essential objectives aimed to reach maximum energy efficiency and a tangible improvement of the usability and functionality of the building. This project demonstrated, for the first time in Austria, the renovation of a large multi-family dwelling to passive house standards. It is therefore a model example for other comparable old buildings. The project partners consistently applied all conceivable measures in order to show that, even in an existing old building, it is possible to reach top indoor air quality, maximum comfort and amenity and, at the same time, very low energy requirements:

- mounting of prefabricated ventilated gap-solar facade elements with translucent thermal insulation
- improvement of roof and basement insulation
- new roofing
- extension of existing balconies including parapet insulation
- passive house window glazing with integrated shading system
- controlled ventilation of living area with single room control

The use of prefabricated solar facade elements made it possible to realize the renovation within a very short time. In addition, prefabrication ensures accuracy and high quality of the individual building components. Single room ventilation provides for excellent indoor air quality, even with windows closed as well as for heat recovery from waste air. Heating costs for a 59 m^2 apartment before renovation amounted to Euro 40.80/month, after renovation Euro 4.73/month. A positive side effect of these measures consists in the mitigation of the enormous noise problem caused by dense traffic in this street. The enlarged balconies with glazing extend the usable floor space and contribute to improving occupants' quality of life.

Project Makartstrasse

ENERGY REQUIREMENTS
(Calculation)

- Before renovation: 150 kWh/m^2a
- After renovation: 15 kWh/m^2a

PROJECT PARTNERS

1 Anwendung der Passivtechnologie im sozialen Wohnbau
Project Coordination: DI Helmut Schöberl, Schöberl & Pöll OEG, Vienna
Heimat Österreich

2 Sozialer Wohnbau, Holz-Passivhaus Mühlweg, 1210 Vienna
Project Coordination: DI Georg Kogler, BAI Bauträger Austria Immobilien GmbH in cooperation with KLH Massivholz GmbH and Dietrich/Untertrifaller, architects, Vienna

3 inkl.wohnen – Wohnpark Sandgrubenweg
Nachhaltige Wohnungsangebote – individuellen und gemeinschaftlichen Mehrwert schaffen
Project Coordination: lic.oec.HSG Gerfried Thür, Rhomberg Bau GmbH, Bregenz

4 Wohnhaussanierung auf Passivhausstandard, Makartstraße, Linz
Project Coordination:
Bmst.Ing. Alfred Willensdorfer, GIWOG Gemeinnützige Industrie-Wohnungs-AG, Leonding

FIGURES / DATA / FACTS

INFORMATIONEN PUBLIKATIONEN

Final reports on the abovementioned studies will be published in the bmvit series "Reports on Energy and Environment Research". Already published: Project 1 (5/2004), Project 3 (41/2006).

The reports are available from:
www.NachhaltigWirtschaften.at/Publikationen
PROJEKTFABRIK
A-1180 Vienna, Währinger Straße 121/3

FORSCHUNGSFORUM in the Internet:
www.NachhaltigWirtschaften.at/Publikationen
in German and English

You will find a complete list of all publications of the bmvit series *"Reports on Energy and Environment Research"* with order form on the HOMEPAGE: www.NachhaltigWirtschaften.at/Publikationen

FORSCHUNGSFORUM *provides information on selected projects within a bmvit program focusing on "Sustainable Development". Published by the Austrian Federal Ministry for Transport, Innovation and Technology (bmvit), Division for Energy and Environment Technologies; Director: Dipl.Ing. M. Paula; Renngasse 5, A-1010 Vienna. Photos and diagrams: Schöberl & Pöll OEG, Arch. DI Franz Kuzmich (Vienna University of Technology, Institute of Building Material Sciences, Building Physics and Fire Protection), BAI Bauträger Austria Immobilien GmbH, Rhomberg Bau GmbH, GIWOG Gemeinnützige Industrie-Wohnungs-AG. Editors: Projektfabrik, A-1180 Vienna, Währingerstrasse 121/3. Layout: Grafik Design Wolfgang Bledl, gdwb@council.net. Printed by: AV+Astoria Druckzentrum GmbH, A-1030 Vienna, Faradaygasse 6.*

FORSCHUNGSFORUM is published at least four times a year and is available for free from:
www.NachhaltigWirtschaften.at/Publikationen

P.b.b. Erscheinungsort Wien, Verlagspostamt A-1010 Wien.