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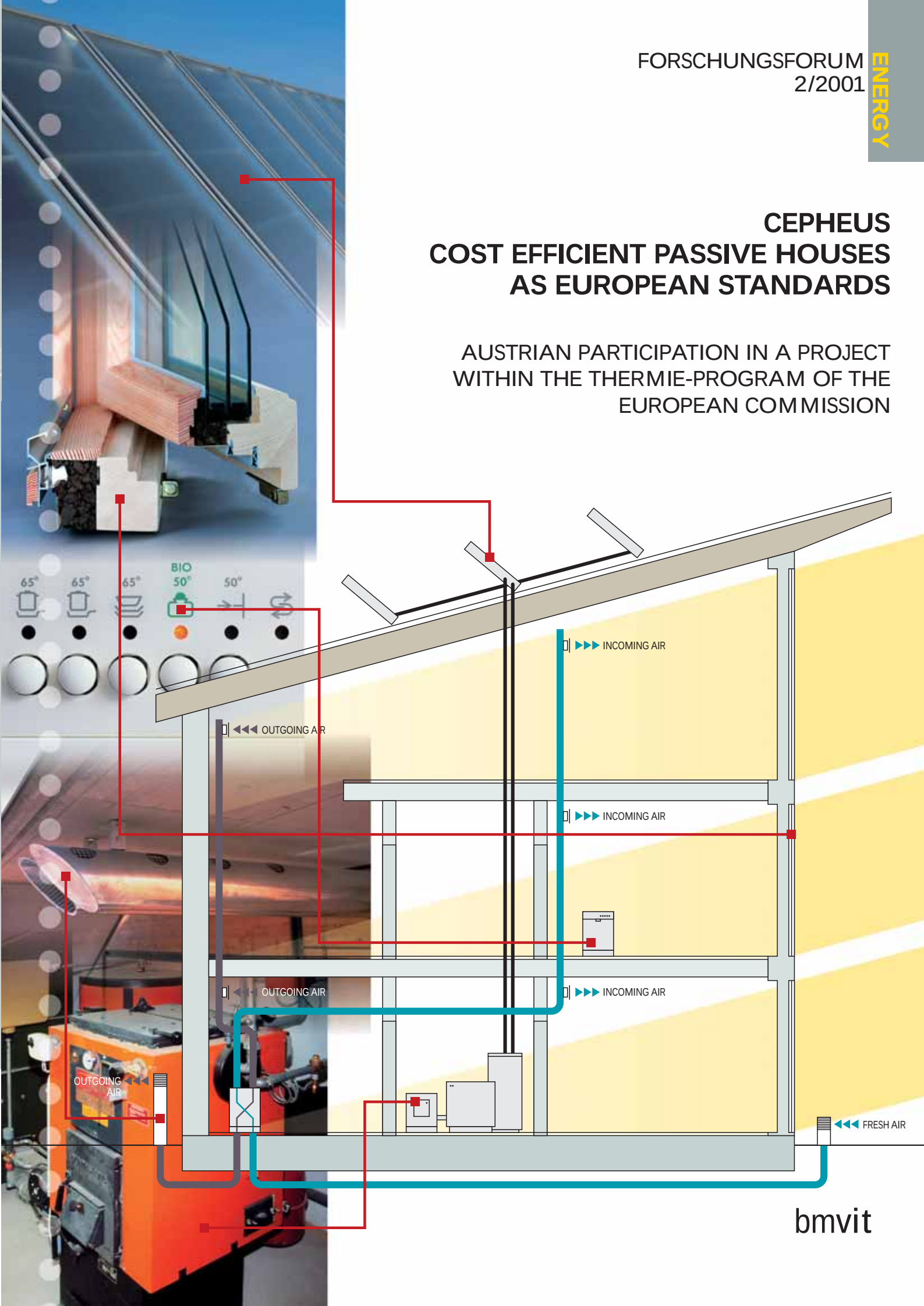
ENERGY

CEPHEUS
COST EFFICIENT PASSIVE HOUSES AS EUROPEAN STANDARDS

AUSTRIAN PARTICIPATION IN A PROJECT WITHIN THE THERMIE-PROGRAM OF THE EUROPEAN COMMISSION



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O B J E C T I V E S

THE CEPHEUS-PROJECT: COST-EFFICIENT PASSIVE HOUSES AS EUROPEAN STANDARDS

The passive house standard: High comfort, minimum energy consumption, and negligible heating costs – environmental protection that pays.

The issue of "sustainability" forms part of future-oriented fields of research and development in today's international discussions. The use of renewable sources of energy and raw materials, a decisive improvement of resource efficiency and user- and service-oriented approaches constitute important aspects of future-oriented technological goals for development.

Within the scope of its stimulation program "Sustainable Development" the Austrian Federal Ministry of Transport, Innovation and Technology (BMVIT) dedicated its sub-program "Building of Tomorrow" to a particularly important issue: future-oriented dwelling and building construction. The goal of the five-year program consists in developing sustainable solutions for parts and components and different types of construction in the fields of residential, office and commercial buildings. Sustainable buildings should take into account, ecological aspects and, at the same time be cost efficient as to construction and operation.

■ In this context CEPHEUS constitutes a future-oriented project, which aims at the development and implementation of innovative building projects at moderate costs. CEPHEUS is being conducted within the scope of the THERMIE program of the European Commission. Austria's partner is the "Energy Institute Vorarlberg", which also coordinates the Austrian activities. CEPHEUS Austria is being supported by the Austrian Federal Ministries BMVIT, BMWA, and BMLFUW as well as by some other partners (Association of Electricity Utilities, Electricity Utilities Vorarlberg AG, Land Vorarlberg, Association of Insulation Manufacturers, and the Energy Institute Vorarlberg).

The objective of the CEPHEUS project consists in the construction of some 250 cost efficient dwellings in ***five European countries*** conforming to passive house standards and including in-process scientific back-up and evaluation of the buildings' operation by means of measurement programs.

This large-scale European initiative is to demonstrate the feasibility of the passive house concept and to develop strategies for the dissemination of the concept as well as to create the prerequisites for a broad market introduction of cost efficient passive houses. The following goals have been defined for the project:

- To demonstrate the technical feasibility (i.e. realizing predefined energy indices) of different buildings and types of construction by different architects and developers in various European countries at only minimal additional costs (which are to be compensated for by savings in the operation of the building)
- To examine the acceptance by investors and potential buyers as well as the user behavior under realistic conditions by means of a representative series of case studies
- To test the applicability of quality standards for passive houses throughout Europe, in particular with a view to cost efficient planning and construction
- To further stimulate activities in the field of energy and cost efficient buildings and to advance the development and marketing of innovative technologies suitable for passive houses.

In the Austrian Laender (provinces) Lower Austria, Upper Austria, Salzburg, and Vorarlberg, different types of passive house have been erected by groups of developers, individual private developers, and housing cooperatives: detached family homes, row houses, multiple story buildings; solid and mixed construction, conventional construction and designs using prefabricated building components. These rather different projects show that the passive house concept can be implemented with various building materials and different types of design at reasonable costs. Selected examples realized in Austria are presented below.

Countries *where cost efficient passive houses have been built include: Sweden (20 housing units), Germany (72), Austria (84), Switzerland (17), and France (40). Most of the houses are already occupied. At present, the concomitant measurement program is under way, and first results will subsequently be analyzed.*

PASSIVE HOUSES REALIZED WITHIN THE CEPHEUS AUSTRIA PROJECT

PROJECT HOERBRANZ

A-6912 Hoerbranz / Developers: private persons
Architect: Ing. R. Caldonazzi, Frastanz
Special planner: Christof Drexel, Bregenz

Completion:
July 1999

Usable floor space:
370 m^2

Heating demand:
qH=13.8 kWh/(m^{2}a)

U-Values:
Exterior wall: 0.11 W/(m^{2}K)
Roof: 0.09 W/(m^{2}K)
Glazing: 0.60 W/(m^{2}K)
Windows total:
0.83 W/(m^{2}K)

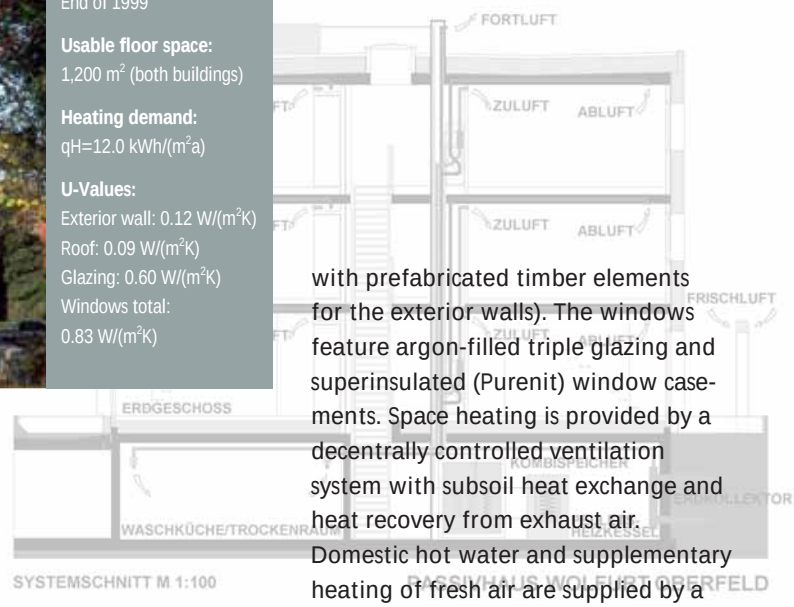
■ This project consists of a row house with three south-facing units, solid construction using a composite thermal system (18 cm brickwork with 38 cm cork insulation). The design aimed at minimizing thermal bridges and at passive and active use of solar energy by means of the south facade.
The timber-frame windows are equipped with krypton-filled triple glazing; the insulation also includes the window frames. The buildings have been equipped with a decentrally controlled ventilation system with heat recovery from outgoing air and subsoil heat exchanger to preheat the incoming air. Additional heating of fresh air is accomplished by means of a 3,000 l solar buffer storage tank and a water-/air- heat exchanger. Supplementary heating is supplied by a heat pump in two units and by a gas heater in one unit. Domestic hot water is supplied by solar collectors (54 m^2), which are integrated in the south facade. Arranging the middle part of the structure crosswise between the two other buildings provides an interesting architectural feature.
This creates for an open space at the northern side of the building, which has been roofed over and glass enclosed, thus forming a wind protected area. This entrance area is separated thermally from the building's shell but provides for sheltered access from the apartments.

Completion:
End of 1999

Usable floor space:
1,200 m^2 (both buildings)

Heating demand:
qH=12.0 kWh/(m^{2}a)

U-Values:
Exterior wall: 0.12 W/(m^{2}K)
Roof: 0.09 W/(m^{2}K)
Glazing: 0.60 W/(m^{2}K)
Windows total:
0.83 W/(m^{2}K)



PROJECT WOLFURT

A-6922 Wolfurt / Developer: private persons
Architect: DI Gerhard Zweier, Wolfurt
Special planner: GMI Ingenieure, Dornbirn, Christof Drexel, Bregenz

■ The project comprises two identical apartment houses with 8 residential units, an office, and a studio. The "back to back" arrangement results a compact structure with minimized shell area. The sophisticated arrangement of the individual apartments and the common staircase provide for flexible use of the individual dwellings. The design used a mixed construction (steel skeleton with reinforced concrete ceilings and concrete slabs for reinforcement, with prefabricated timber elements for the exterior walls). The windows feature argon-filled triple glazing and superinsulated (Purenit) window casements. Space heating is provided by a decentrally controlled ventilation system with subsoil heat exchange and heat recovery from exhaust air.
Domestic hot water and supplementary heating of fresh air are supplied by a solar installation (approx. 62 m^2 collector area on the roof and a 2,500 l combined storage tank for each building) and a central pellets-fired heating boiler. The buildings are equipped with a basement, basement parking facilities, and common laundry and drying rooms.

Completion:
Spring 2000

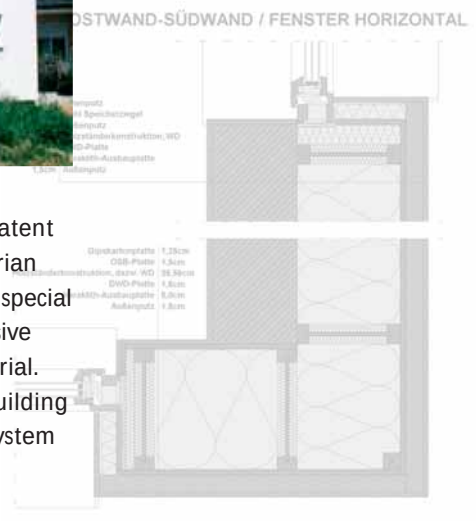
Usable floor space:
170 m²

Heating demand:
qH=14,8 kWh/(m²a)

U-Values:
Exterior wall: 0.10 W/(m²K)
Roof: 0.09 W/(m²K)
Glazing: 0.60 W/(m²K)
Windows total:
0.82 W/(m²K)

HORN

A-3580 Horn
Developer: Buhl Bauunternehmens GmbH
Architect: Dr. Martin Treberspurg, Vienna
Special planner: Wilhelm Hofbauer, Vienna



This single-family home was developed as prototype for series production of prefabricated buildings conforming to passive house standards. Some follow-up projects have already been realized or are at the planning stage.
The building is a mixed construction, exterior walls are made partly of masonry, other parts use prefabricated timber elements with cellulose insulation. The brickwork exterior walls have been clad with lightweight facing. This permitted to fit the whole building shell with 30 – 40 cm cellulose insulation. The design was granted a patent as "BUHL-Passivwand". The Austrian company BUHL also developed a special insulating building block for passive houses made from recycled material.
Heating and ventilation of the building rely on a controlled ventilation system with subsoil heat exchanger and heat recovery.
Remaining energy demand is met by fresh air preheating by means of a pellets-fired heating boiler. Hot water supply is covered, in part, by a 10 m² solar installation; a 1,000 l combined boiler/buffer serves as heat storage.

HALLEIN

A-5400 Hallein
Developer: Experta Wohnbau GmbH, Hallein
Architect: Otmar Essl, Hallein
Special planner: Erich Pusterhofer

Completion:
November 2000

Usable floor space:
2,334 m²

Heating demand:
qH=12,4 kWh/(m²a)

U-Values:
Exterior wall: 0.11 W/(m²K)
Roof: 0.11 W/(m²K)
Glazing: 0.70 W/(m²K)
Windows total:
0.79 W/(m²K)

This residential building constitutes the largest Austrian CEPHEUS-project, it consists of 4 individual structures arranged around a common courtyard, with 3 or 4 stories each and a total of 31 units. The project aimed at minimizing energy losses by means of a compact design, excellent insulation, and by active and passive utilization of solar energy. The design uses a mixed construction: A steel skeleton structure has been combined with timber frame elements (3-layered walls with 38 cm insulation overall). The window casings are also insulated and feature argon filled triple glazing. Heating and ventilation are realized by means of a controlled ventilation system with heat recovery; a central wood pellets heating boiler covers supplementary heating demand. A solar installation with a collector area of 120 m² and central 5,000 l layered storage supplies domestic hot water. An important aspect of this project consists in the numerous building services for joint use such as hobby rooms, a small "amphitheater" within the courtyard, a drying room as well as a common deep freeze room. The project was awarded third place in the Energy Competition of the Land Salzburg.

WHAT MAKES A BUILDING A PASSIVE HOUSE?

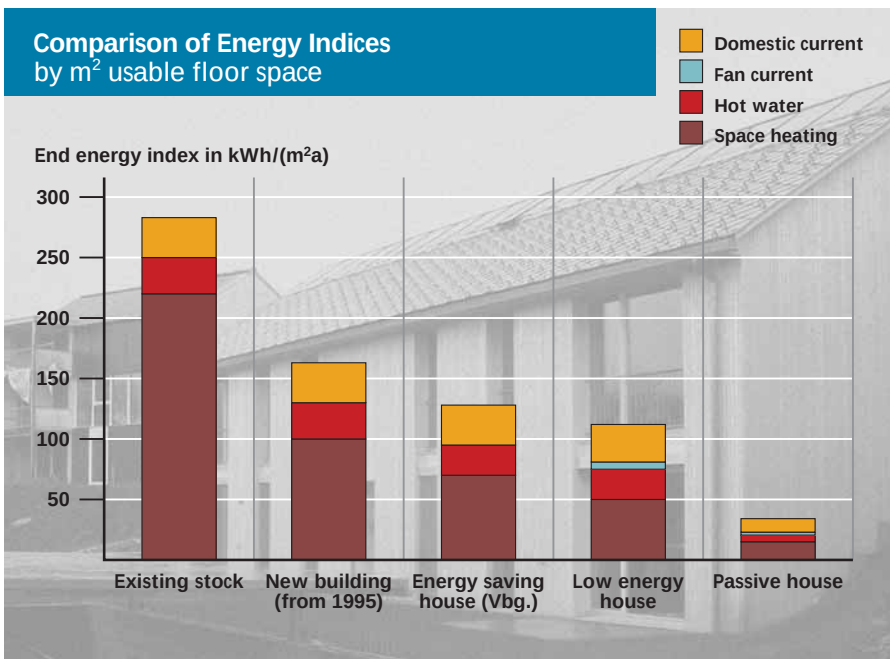
The passive house standard is a cost efficient approach to minimize the energy demand of new buildings and, at the same time, to ensure a high degree of occupant comfort. This approach is particularly cost efficient because it focuses on those components of a building that are indispensable anyway: the building shell, the windows, and the ventilation system. These components are optimized in such a way that a separate heating system can be dispensed with.

The term "passive house" refers to a building that provides for a comfortable indoor climate, in summer and in winter, without using a conventional heating system. This requires that the annual energy demand for heating can be met by preheating incoming fresh air in the existing ventilation system. Passive houses use approx. 80% less energy for heating than conventional new buildings.

At the same time, demand for other forms of energy in a passive house, in particular domestic current for household appliances, should be minimized by the use of energy efficient technologies. One of the objectives defined within the CEPHEUS-project was that the total energy demand for heating, domestic hot water, and household should not exceed 42 kWh/ (m^2a).
The **following features** characterize the **passive house:**

Extreme insulation of the building shell
Passive houses are equipped with an excellent thermal insulation; joints between individual building components are designed in such a way as to avoid thermal bridges and ensure maximum air-tightness. Certain minimum requirements for the insulation coefficient of the building shell (U-value approx. 0.1 W/ m^2K) are necessary in order to dispense with a conventional heating system without impairing occupant comfort.

Efficient ventilation and heating system
Passive houses are constantly supplied with fresh air by means of a ventilation system. A very efficient heat exchanger extracts heat from the exhaust air and transfers it to the incoming fresh air. The two air flows are not mixed.
On particularly cold days, supply air is further preheated if necessary. Additional preheating of incoming fresh air can be accomplished by a subsoil heat exchanger, which further reduces the need for back-up heating.



Passive use of solar energy
South-facing passive houses are designed as solar houses. After the potentials of insulation and heat recovery have been exploited, the passive use of solar irradiation compensates about 40% of the remaining heat loss. To achieve this, windows are usually equipped with triple glazing and superinsulated frames. Thus, these windows let in more solar heat than is lost through them. An optimal solution should use south-facing glazing surfaces that are not shaded.

Efficient use of electricity
Equipping the building with efficient household appliances, hot water connections for washing machines and dishwashers, airing cabinets, as well as compact fluorescent lamps has been recommended to the occupants. This will reduce domestic electricity consumption by about 50% as compared to the average housing stock.

Use of renewable sources of energy to cover remaining energy demand
As the remaining energy demand of a passive house is very small, all of it (space heating, hot water, and domestic current) can be covered by renewable sources of energy. Cost-optimized solar thermal systems are able to meet about 40 – 60% of the low-temperature heat demand (heating and hot water) of a passive house.

CEPHEUS AUSTRIA: PROJECTS AND INFORMATION

At nine sites in four Austrian Laender different types of passive house with a total of 84 housing units and approx. 7,000 m^2 of usable floor space have been built within CEPHEUS Austria.

Vorarlberg:
1 multifamily building with 4 units at Egg, 2 multifamily buildings with 10 units at Wolfurt, 1 row house with 3 units at Hoerbranz, and 1 single-family house as prototype for a passive house system at Dornbirn.

Salzburg:
2 large housing developments with 25 units at Kuchl and 31 units at Hallein as well as an apartment building with 6 units at Salzburg, Gnigl

Upper Austria:
1 row house with 3 units at Steyr

Lower Austria:
1 single-family house at Horn, serving as prototype for series production

The types of construction vary greatly, 3 projects use solid construction with integrated insulation system, and the other projects rely on mixed construction with solid supporting structure and prefabricated timber wall and roof elements.

The first results from the measuring programs will be available within the next few months. However, as the buildings were completed and ready for occupation only in the winter of 2000, these results will have only a limited relevance (on account of the drying phase and the usual rectifications). The first heating period yielding relevant results for analysis will be winter 2001/2002.

Up-to-date information, data on the projects, and addresses are available at www.cepheus.at and www.cepheus.de.

The Energy Institute Vorarlberg is CEPHEUS partner for Austria and has been commissioned with the organization of measuring programs and the coordination and documentation of the projects.

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PUBLICATIONS

"Building of Tomorrow" is a subprogram within the BMVIT stimulation program "Sustainable Development". Information and publications on the topic are available at www.hausderzukunft.at

Detailed reports on the Austrian projects within CEPHEUS are available from the Energy Institute Vorarlberg and at www.cepheus.at.

You will find a complete list of all publications of the series ***"Reports on Energy and Environment Research"*** published by the BMVIT on the FORSCHUNGSFORUM HOMEPAGE: www.forschungsforum.at

F I G U R E S / D A T A / F A C T S

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