NACHHALTIG*wirtschaften*
konkret

FORSCHUNGSFORUM
2/2005

THE "SCHIESTLHAUS" IN THE HOCHSCHWAB REGION – ALPINE REFUGE USING PASSIVE HOUSE TECHNOLOGY

IMPLEMENTATION OF AN INTEGRATED BUILDING DESIGN IN "ISLAND LOCATION" WITHIN THE "BUILDING OF TOMORROW" SUB-PROGRAM

bmvit
Austrian Federal Ministry for Transport, Innovation and Technology


Photo: Geischläger Bau

THE SCHIESTLHAUS – ENERGY SELF-SUFFICIENT MOUNTAIN REFUGE BUILT TO PASSIVE HOUSE STANDARDS

■ Alpine mountain refuges are a typical example of buildings in "island locations" in Austria and in the whole alpine region. They are situated at locations that are exposed, difficult to reach, and ecologically very sensitive. Their location far away from the public networks of water and power supply as well as of sewers often causes great problems concerning supplies as well as high environmental impacts. On the other hand, they are situated in places where solar irradiation is significantly higher than average and therefore offer a great potential for the use of solar systems for energy supply. In recent years, some operators already have taken measures towards solar and energy-efficient building designs in the course of the renovation or new construction of mountain refuges.
The measures focused on the use of photovoltaics and solutions for an environmentally acceptable wastewater disposal.

Research within the sub-program "Building Of Tomorrow" resulted in a pioneering integrated concept for an energy self-sufficient mountain refuge.
Based on a study project realized at the Vienna University of Technology a planning team cooperating with many project partners planned and implemented the new construction of the Schiestlhaus on Mount Hochschwab according to the principles of solar building and passive house standards.

The Schiestlhaus of the Austrian Tourist Club (ÖTK) is situated at an altitude of 2154 m above sea level on a plateau directly under the main summit of the Hochschwab. As the existing, already 120 year old building is in a very bad condition, the owner decided for a replacement. The ÖTK agreed to realize a pilot project: The first large mountain refuge built to passive house standards. The new refuge will accommodate 70 people. So far, the Schiestlhaus has been used from the beginning of May until the end of October. Planners already considered extending the period of operation.

As the refuge is at a great distance from any kind of infrastructure, planners aimed to develop a self-sufficient type of building, which uses an integrated package of thermal collectors, photovoltaic elements, and sufficient storage capacities for power and heat supply. In addition, the special conditions of this location with a view to nature and environment conservation (the sources for the second water supply pipeline to Vienna are situated in the Hochschwab area) as well as the requirements resulting from the special use of the building had to be taken into account.

What was needed was a system that met the complex requirements of building construction in an alpine environment. The design should be able to withstand the extreme loads resulting from wind and snow pressure. At the same time, the difficult conditions for transportation and assembly and the concomitant costs called for special solutions. As the Schiestlhaus can neither be accessed via road nor does it have a freight cable car all building material had to be transported by helicopters. Drinking water supply required the development of a complex system of rainwater use because there are no water sources in a practicable distance.

The development of an overall integrated system that meets these manifold specifications requires close cooperation between designers, planners, and professionals as well as networking between research and practice. The realization of the Schiestlhaus has created a prototype for solar and ecological building construction in alpine island locations. The project partners are testing a number of sustainable technologies and a sophisticated concept for the floor plan under extreme conditions. The solutions and findings resulting from this project may be used – with slight modifications – for other building projects in similar alpine conditions.


Photo: Projektfabrik

In 1999, the Austrian Federal Ministry of Transport, Innovation and Technology (bmvit) launched the research and technology program "Sustainable Development", which aimed to effectively stimulate the restructuring of the economy towards sustainability. 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 consumption, 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. The "Building of Tomorrow" builds upon the two most important developments in the field of solar and energy-efficient building design: solar low-energy and passive house design.

INNOVATIVE TECHNOLOGICAL SOLUTIONS FOR THE BUILDING

■ The specifications of the building (passive house standard – self-sufficient energy supply – controlled incoming and outgoing air) require an overall integrated concept for all components of domestic technology and electrical equipment. In order to be able to develop optimized solutions, the various project partners had to do a lot of preparatory work, e.g. the thermal simulation of the building by means of TRNSYS, the simulation of the photovoltaic installation as well as drawing up an end-use energy balance.

The issue of energy supply raised the question of how to design a useful combination of passive and active use of solar energy, use of internal heat sources (persons, heat dissipation from the kitchen), and environmentally sound additional energy sources (wood, rape oil, wind).

The south-facing facade has been designed as an **energy- facade system** and is the main energy supplier of the building.

- The bottom story has large windows and serves the passive use of solar energy.
- The upper story features 46 m^2 of facade-integrated solar collectors for the generation of thermal energy. According to simulations, the proportion of solar energy will thus be some 80%.
- A photovoltaic system with a total surface area of 68 m^2 has been installed in front of the solid construction bottom story.

HEATING / VENTILATION SYSTEM

One of the goals of the project was to heat the whole building by means of a ventilation system. On account of the excellent thermal quality of the building envelope and controlled incoming and outgoing air with heat recovery, the refuge will be thermally self-sufficient when fully occupied.

The common rooms will be heated for the most part by means of preheated fresh air. A special rotary heat exchanger transfers the greater part of heat and humidity from the outgoing to the incoming air. Additional radiators are planned for the washing and drying rooms. Design temperature for the main common rooms was based on the usual requirements for a comfortable ambient temperature of 20º to 26º C. The minimum temperature for sleeping rooms, corridors, and toilets is 15º C, for drying rooms 20º C. The storage rooms in the basement have to be frost-free and should not warm up to more than 10º C. When the refuge is not in operation the danger of freezing must be excluded for the whole building.

Ventilation complies with passive house standards and uses fresh air equipment with high-performance heat exchangers with an efficiency of up to 85%. In addition, they use bypass valves in order to avoid overheating in summer operation through internal heat sources. The ventilation units take in air from outside through a snow-protected opening at the northern facade and blow out the exhaust air through a roof-mounted duct. In order to avoid disturbing sound transfer from the ventilation ducts (telephone effect), the individual rooms are acoustically separated by means of sound absorbers.

Ventilation

Diagrams: pos architekten

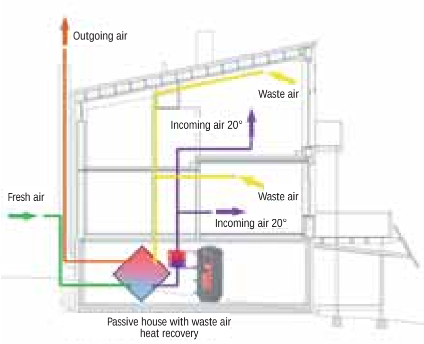


Photo: Projektfabrik

Photo: Treberspurg&Partner Architekten

An important internal heat source is the kitchen. The kitchen waste air hood is equipped with washable grease filters, a cleanable pipe bundle heat exchanger and a preheater.

HEATING / HOT WATER

Heat supply and storage is effected by means of three buffer storage tanks with a total capacity of 2,000 litre which are fed, for the most part, by the facade integrated thermal collectors.

In the kitchen, an additional wood-fired range with heat exchanger will be installed, which serves for cooking and for charging the buffer storage tank. In case of low occupancy of the refuge (e.g. pre- or after-season) the remaining heating requirement can be covered by this kitchen range or from the hot water storage tank.

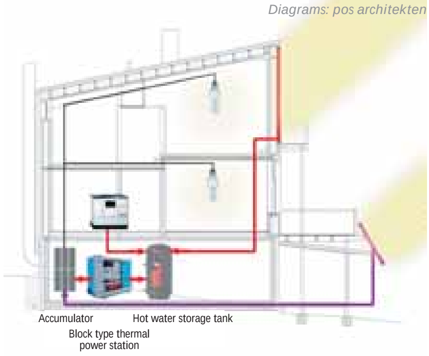
Heat supply thus relies on the following system:

- The solar collector transfers heat via heat exchanger to the buffer storage tanks.
- A rape oil operated unit (see below) loads heat directly into the buffer storage.
- The solid fuel range can also transfer heat into the buffer storage tanks.

Problems of overheating are not likely to occur in this system because even in mid-summer temperatures are moderate and range between 0° and 20° C.

Heat and power supply

Diagrams: pos architekten



POWER SUPPLY

One important factor in planning the whole domestic technology was power consumption: Given average solar irradiation, more than 60% of the annual electrical energy requirement can be covered by the 7,5 kWp photovoltaic system. The installation was mounted in front of the parapet of the terrace because the major part of the facade is being used for the solar thermal collectors. Only a small part of the facade was also equipped with photovoltaic panels.

The remaining power requirement is provided by a rape oil operated block-type power plant, which also serves as backup for power and heat supply (see above).

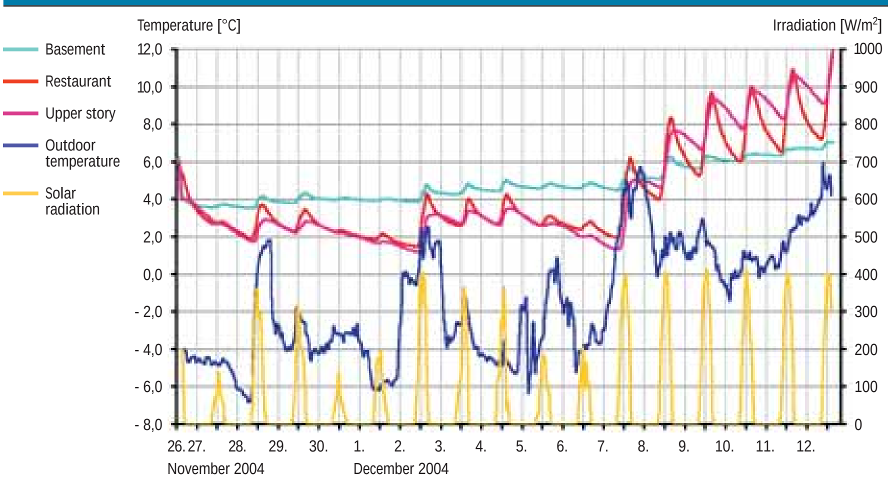
The concept uses only highly efficient appliances and lighting media with extremely low power consumption. In order to make energy-optimized use of all electric consumers they are released in a switching hierarchy.

Photo: Projektfabrik

If, for instance, the accumulator capacity falls below 50%, all secondary consumers automatically remain blocked until the accumulator capacity has reached 70% again. The installation was also designed in such a way that all appliances with a high power demand mutually block each other so as to prevent the simultaneous operation of power demanding appliances (e.g. vacuum cleaner and dish washer).

Photo: Projektfabrik

First measuring results: Solar radiation / Temperatures



Source: Pilz Umwelttechnik/Ingenieurbüro Wilhelm Hofbauer

After completion of the building envelope in November 2004 first temperature measurements were carried out in the building, which was unoccupied and not yet completely insulated at the time. The measuring results for external temperature and solar irradiation were taken from the local meteorological station, which is mounted some 200 m from the Schiestlhaus (Pilz Umwelttechnik). The diagram shows a temperature rise to approx. 12° C within the building, which resulted from a series of sunny days from Dec. 8 to 13, 2004.

DEVELOPMENT OF THE BUILDING CONCEPT AND EXECUTION OF CONSTRUCTION WORK

Planning - Space Arrangement - Design

Photo: Projektfabrik

Architectural and overall building concepts are based on the principles of solar building construction. The building site on Mount Hochschwab permitted a clear southward orientation of the building and thus the active utilization of solar irradiation, which is particularly favorable at this altitude. Technically, the concept follows passive house standards, and is adapted to meet the meteorological and geological requirements prevailing in alpine regions. From an economic point of view, logistics and the weight of building components were important issues. Designers developed a clear-cut principle of construction and a simple structure with prefabricated building elements, which can be realized within short building and assembly times.

An important factor for the energetic performance of the building consists in a clear orientation of the design on solar energy: Large windows towards the South provide for optimum solar gain. Towards the North, East, and West, the facades have only few openings to minimize thermal losses. This requires “solar zoning” in the internal arrangement of spaces: Frequently used day rooms and the restaurant are oriented towards the South, all secondary rooms such as corridors, hall-stand, etc. are located in the center of the building and towards the North.

The restaurant of the new Schiestlhaus will be based on a highly innovative space concept: A generous room with the sun streaming in with high-quality passive house strip windows. The resulting passive solar gain is reflected in the temperature profiles during this year’s winter vacation (See figure above).

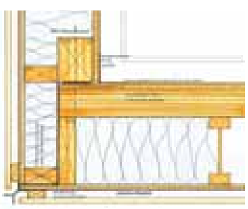
For the structural framing **wood** was chosen as a building material , which is best suited to meet the requirements of building construction in an alpine environment (structural design, prefabrication, transportation, weight). All building elements had to be planned and prefabricated with extreme dimensional accuracy because corrections on the building site are not possible. On account of the prevailing extreme conditions, special solutions had to be developed for a number of details.

The structural walls use special, prefabricated wood frame elements, which meet the demanding structural requirements. The elements are arranged along the main axes of the building and constitute the main framework that takes up and distributes all forces. According to passive house standards the building envelope is equipped with **high-performance thermal insulation**, all joints between building components are airtight. The outer walls use a multilayer construction with insulation in between as well as a vapor barrier and air sealing . The facades consist of a horizontal larch boarding in front of a 3 cm air layer.

The roof and ceiling elements were also prefabricated and put in place by means of a helicopter. The roof insulation was mounted in the process of prefabrication at the plant as well. Thus, the building was protected against extreme temperatures immediately after completion of the envelope.

The bottom floor was designed in solid construction as it houses all technological equipment (rainwater and wastewater treatment, ventilation controls, hot water storage, accumulators, etc.) as well as the storage rooms. Measuring results have shown that frost-free storage during winter will be possible in the basement, which allows to keep provisions there, thus considerably facilitating the starting phase in spring.

Photo: Treberspurg&Partner Architekten



Scheme: Holzbau Harrer GmbH

Joint between two elements, air sealing, and vapor barrier. Airtightness is the most important characteristic of passive house design: The foil had to be fixed directly to the wood frame first, because after mounting of the elements by means of helicopter, the joint between frame and wall element is not accessible anymore.

WATER SUPPLY AND WASTEWATER TREATMENT IN THE NATURAL RESERVE

The Schielstlhaus is situated at an ecologically highly sensitive location in a nature reserve. The Hochschwab massif is the catchment area for the second drinking water pipeline to Vienna. Sustainable safeguarding of this drinking water reserve has the highest priority and entails strict requirements for the operation of the mountain refuge.

There are no usable water sources in the vicinity of the refuge, so the whole water supply has to be collected from precipitation and stored in a cistern. The cistern has been installed in the western part of the basement and has a capacity of 34 m^3. The rainwater is fed via coarse filter into a drinking water tank, then passes through a cascade of fine filters and a UV sterilization unit and finally yields pure drinking water. As the refuge is subject to the regulations applicable for restaurants, the requirements concerning water quality are particularly strict. One of the prerequisites for purified rainwater to be used in the kitchen was the installation of a food safe stainless steel roof.

Concerning the problematic issue of disposal the project partners also had to develop a special system of wastewater and solid waste treatment. On account of the limited washwater supply and in order to minimize wastewater generation only dry toilets were installed in the refuge. The eastern part of the basement houses a multi-stage, fully biological wastewater treatment plant with UV-sterilization where all wastewater passes through. The degree of purification after the wastewater has passed all steps is 99%, which corresponds to "good bathing water" quality. This biologically purified wastewater is then discharged into the open where it is left to seep into the soil. There are regular supply flights, which are also used to transport solid waste to the valley where it is disposed.

Use of rainwater

Diagrams: pos architekten

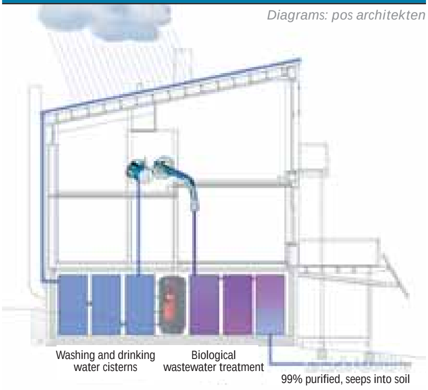


Photo: Geischläger Bau

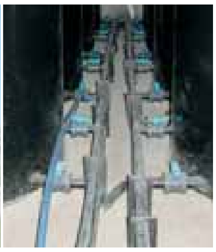


Photo: Treberspurg&Partner Architekten

PROJECT PARTNERS

The project originated within the "Building Of Tomorrow" sub-program.

ALPINER STÜTZPUNKT – SCHIESTLHAUS AM HOCHSCHWAB

Project partners:
ARGE solar4.alpin, Marie Rezac, Karin Stieldorf, Fritz Oettl, Martin Treberspurg
Vienna 2002

Realization/Contact:
Pos architekten ZT KEG (Planning)
Arch. Fritz Oettl
oettl@pos-architekten.at

Treberspurg & Partner
Architekten ZT GmbH. (AVA+ÖBA)
DI Marie Rezac, DI Christian Wolfert
office@treberspurg.at

Consultancy:
Building physics: Wilhelm Hofbauer, Karin Stieldorf, IBO, Vienna
Structural analysis:
Robert Salzer, Hohenberg,
Gerald Gallasch, Vienna
HLS, Solar Thermie:
e+c Wimmer, Vöcklabruck
Photovoltaics, Electrical engineering:
ATB Becker, Absam
Wastewater treatment:
TB Steinbacher, Thalgau
Lighting design: Klaus Pokorny, Vienna

INFORMATION PUBLICATIONS

The final report on the abovementioned study has been published in issue 7/2002 of the bmvit series "Reports on Energy and Environment Research" and is available from:
www.NachhaltigWirtschaften.at

PROJEKTFABRIK
A-1190 Wien, Nedergasse 23/3
versand@projektfabrik.at

FIGURES / DATA / FACTS

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

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

FORSCHUNGSFORUM *provides information on selected projects within a bmvit program focusing on "Sustainable Economy". 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, Austria; Photos and diagrams: see credits at the pictures, Cover Projektfabrik. Editors: Projektfabrik, Nedergasse 23, A-1190 Vienna, Austria. Layout: Grafik Design Wolfgang Bledl. Printed by: AV+Astoria Druckzentrum GmbH, Faradaygasse 6, A-1030 Vienna, Austria.*

FORSCHUNGSFORUM is published four times a year and is available for free from:
Projektfabrik, A-1190 Vienna, Nedergasse 23, versand@projektfabrik.at

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