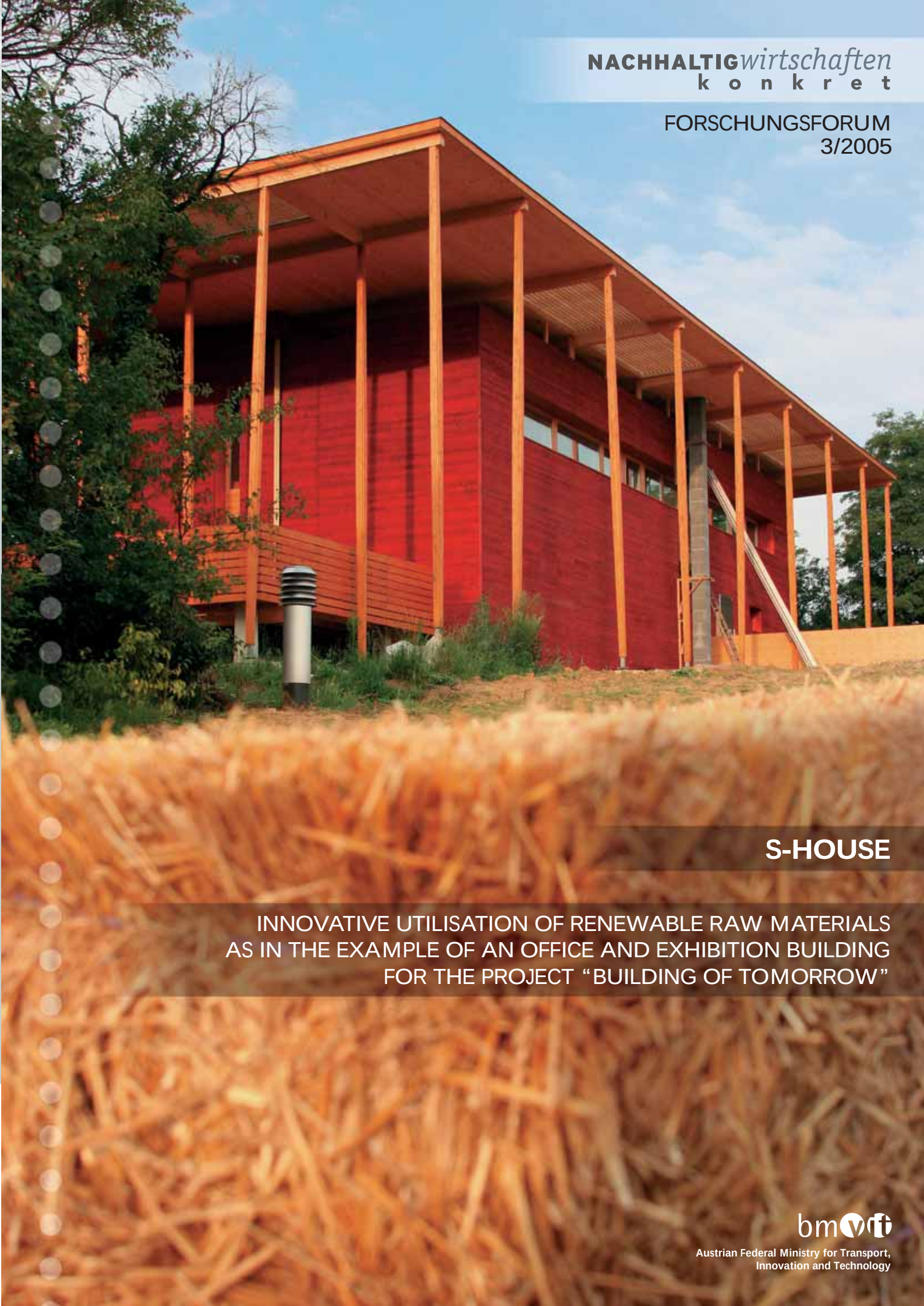

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FORSCHUNGSFORUM
3/2005

S-HOUSE

INNOVATIVE UTILISATION OF RENEWABLE RAW MATERIALS AS IN THE EXAMPLE OF AN OFFICE AND EXHIBITION BUILDING FOR THE PROJECT "BUILDING OF TOMORROW"

bmvit
Austrian Federal Ministry for Transport, Innovation and Technology

P R O J E C T

THE S-HOUSE – PLANNING AND BUILDING FOR TOMORROW

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 market is a business segment with particularly large volume flows and very high power consumption resulting from manufacturing processes, transportation and deconstruction of building components and structures. Moreover, large quantities of building waste pose a problem and lead to high environmental pollution and are consequently responsible for high cost of their disposal.

Sustainable building concepts follow the idea of re-circulation, which means, the entire lifecycle of materials and structures used and the streams of energy necessary in all life cycle phases must be taken into account while planning and its implementation. Today, it is obvious that, besides efficient utilisation of solar energy, a decisive use of renewable raw materials in the building systems can lead to future-oriented solutions and thereby sparing resources.

Today, there is wide range of products made of renewable raw materials and available to the building market. In this regard, largely native resources can be used that will contribute to the enhancement of regional economic worth. Building materials obtained from renewable raw materials ensure simple rebuilding and optimum reusability after using them for constructional purpose.

Within the framework of the subprogram "Building for Tomorrow", the Center of Appropriate Technology (GrAT/Gruppe Angepasste Technologie) at the Vienna University of Technology developed an integrated total concept with its "S-HOUSE" that combines all relevant aspects of sustainable building methods.

An innovative building project has resulted with the S-HOUSE, which meets the high standard of energy for the passive house technology and also demonstrates the appropriate use of building materials derived from renewable raw materials. In addition, a large number of suitable solutions have been developed that enable problem-free reusability of all building materials used after completion of their lifespan.

Besides wood, straw was used as a building material in particular, the physical properties, highly effective heat insulating ability and burning pattern of straw were tested during extensive studies (within the framework of "Building of Tomorrow" as well). During the entire development of the project, close cooperation between research and practice as well as a number of partners and experts attained major significance. New technical solutions were developed in many fields for implementation in the actual building activities. One of the objectives of the project is also to develop these constructions subsequently into series production.

The S-HOUSE acts as an office and exhibition building and as a turntable for dissemination of information on sustainable building methods. For the project, spreading the know-how and experience acquires much importance. Even during the set-up phase, the results of the planning processes were discussed thoroughly at international forums as well.

The project was presented at the EXPO 2005 in Japan where it received the "Global 100 Eco-Tech Award" as one of the best projects worldwide in the field of resources efficiency and safeguarding the climate. Further international activities such as a design competition are held in Japan.

R E S U L T S

THE S-HOUSE: "FACTOR 10 BUILDING" WITH INNOVATIVE SOLUTIONS

With the S-HOUSE, the Factor 10 Concept is implemented in the building segment, which meets the criteria for sustainable building. By using building materials derived from renewable raw materials and the passive house technology, the consumption of resources during the construction of a building could be minimised by Factor 10 as compared to conventional construction methods according the state-of-the-art technology. The comparison of a straw wall construction with a conventional wall construction has shown that the straw wall scores better by the Factor 10 in all criteria of calculations, which means, for a conventional concrete wall construction the consumption of natural resources is 10-times higher. The consumption of resources during the building activities could be minimised through innovative solutions used up to a factor of 20. These calculations were made in cooperation with the Austrian Institute for Building Biology and Ecology (IBO/Österreichisches Institut für Baubiologie und Ökologie).

In the construction of the S-HOUSE, many innovations and specific solutions were implemented, so as to meet the requirements of sustainable building techniques. Here an important aim was to spare the resources and minimise building leftover materials during construction of the building and to reuse all building components in order to avoid environmental pollution even after the usage period of the building. Due to the special construction of the building (see above individual footings / sub-ventilated building slab) and the avoidance of a cellar, even preparatory works at the building site could be done without wasting much of the building materials. The hollow spaces for individual footings were covered with film material after excavation in order to enable easy removal of the foundations. Each individual footing is prepared for easy removal and disposal later.

Particularly innovative was the collection of clay plaster for external application. The excavated material collected while preparing the individual footings and the installation shaft was stored so as to reuse it later. After the clay containing earth material was separated from the humus layer and was made free from organic substances, it was subsequently possible to process it into clay plaster for the walls of straw bales. **This "direct material recycling" indicates an important alternative to the conventional method of building where large quantities of ground excavation and building leftover materials normally accrue.**

By using raw materials (clay and straw) available on-site or in the region, environmental pollution caused by the manufacture and transportation of building materials can be minimised. With the clay plaster applied directly on straw, an alternative to the otherwise commonly used films (mostly compound material made of fossilised synthetics) is available. Presently, this method of plastering is not being offered in the market. Therefore, this is one of the new developments for the S-HOUSE.

TREEPLAST – STRAW SCREW

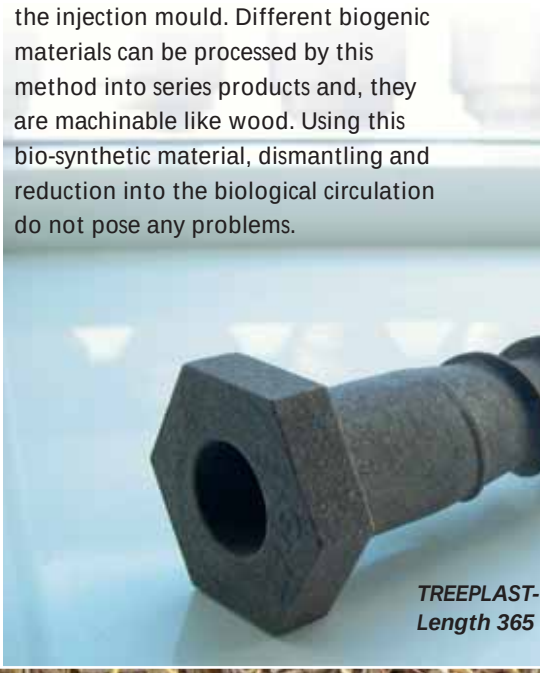
An important objective of the project was to develop a design element that enables construction of a wall structure with straw insulation that is free of thermal bridge. Using the TREEPLAST screw especially developed for the S-HOUSE, it is possible to directly fix them in the straw bales. With this, external facades can be mounted without thermal bridges or later fixtures can be implemented in the straw wall in the inside of the building. The aim of the screw design was to achieve a maximum mechanical strength at minimum material consumption.

In this new development the following technical criteria should be fulfilled:

- Efficient assimilation of tensile force in axial direction
- Quick and simple mounting
- Efficient assimilation of vertical force
- Least deformation resulting from bending momentum
- Simple mounting of wooden planks
- Other elements can be fixed to the screw at mm precision

The screw has been optimised during its development according to bionic criteria. Bionics as a discipline of science is mainly concerned with the application of biological principles in technology. Many principles of design, methodology and development seen in nature can be applied in many fields and especially in the building sector.

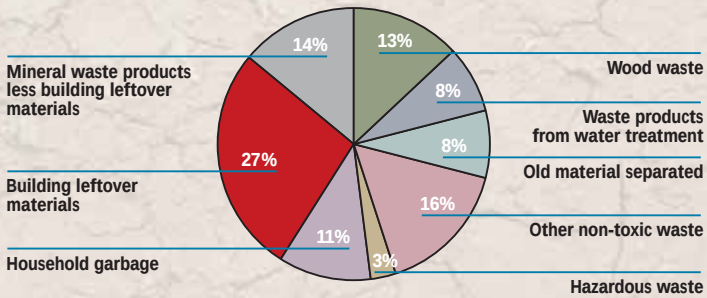
As a bio-synthetic material, TREEPLAST combines the advantages of renewable raw materials with those of the modern synthetic material processing such as the injection mould. Different biogenic materials can be processed by this method into series products and, they are machinable like wood. Using this bio-synthetic material, dismantling and reduction into the biological circulation do not pose any problems.



TREEPLAST-Length 365

Austria's annual waste production

Percentage of building leftover materials in the entire amount of waste less ground excavation



Source: Bundesabfallwirtschaftsplan 2001

BIOMASS-STORAGE STOVE

For covering the thermal load peaks, a biomass-storage stove has been integrated into the heating and air distribution system. This unit is a prototype of a newly developed biomass-storage stove in the low performance range (2.5 to 5 KW) which has been developed in the course of this project for passive house compatibility (Robert Wimmer/GrAT). The stove operates similar to the principle of ceramic tiled stoves, which means heat can be stored and delivered through the ventilation system at staggered timing. Using a simple controlling and regulating technology, complex relations between the external temperature, solar radiation, and internal loads such as operating the devices and burn down behaviour of the stove can be regulated.

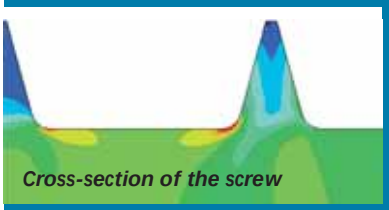
An important objective of this new development was also to take the users needs into account with regard to user comfort. User surveys indicate that the absence of a fire place and therefore a "warm" core in the living room is often seen as a deficiency in passive houses. This new biomass-storage stove with a large visor allows direct viewing of the heat source even in the passive house.

TECHNOLOGICAL SOLUTIONS FOR THE BUILDING

Due to optimum insulation of the building and the passive house technologies used, the S-HOUSE achieves a low energy consumption (6 kWh/m^{2}a), which is far below the standard required for a passive house (energy consumption 15 kWh/m^{2}a).

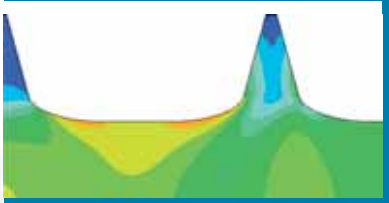
The heat is captured by the large surface glazed south facade and distributed over a mechanical ventilation and exhaust system into the building. The air is transported by specially developed wooden channels into all areas of the building. In the ground floor, a stone floor acts as heat retainer. These stone tiles are the only mineral material that is used in the S-HOUSE. These stone tiles are glued using a natural adhesive substance so that recycling is ensured even here. An earth commutator takes care of temperature balancing: during winter it prevents glacial formation in the ventilation system and during summer it serves as a cooling device. Due to a centrally located ("Backbone") supply cable very short conduction paths are achieved in the intermediate ceiling area for the electrical power supply and illumination. A day-light controlled regulating system ensures efficient operation of the illumination system.

Bionic optimisation of the screw thread



Cross-section of the screw

Dissipation of tensile and flexural stresses (red indicates areas of high load stress, whereas green indicates medium and blue indicates low stress areas)



After the bionic optimisation, the red areas have disappeared, although the thread base is deformed only negligibly.

Source: Center of Appropriate Technology / Vienna University of Technology

Straw screw mm, ø 37 mm

RESEARCH & DEVELOPMENT AND IMPLEMENTATION IN THE BUILDING CONCEPT

Fundamental studies – Design – Evaluation

■ Planning and realisation of the office and demo building S-HOUSE is based on the results obtained from the research work conducted by the Center of Appropriate Technology (GrAT/Gruppe Angepasste Technologie) within the framework of "Building of Tomorrow" at the Vienna University of Technology in cooperation with various partner organisations. In the course of their fundamental research studies, the technical, legislative/political and organisational scope of utilising renewable raw materials in building systems were envisaged and tangible designing solutions were developed.
(see FORSCHUNGSFORUM 4/2002)

Thus, for example, in the course of the project **"Wandsysteme aus nachwachsenden Rohstoffen"** (GrAT in cooperation with IBO, Vienna 2001), different basic techniques for a wood-post wall system with straw isolation were evolved and the feasibility of straw as a construction material in terms of its burning pattern and heat conductivity was tested and certified. Investigations indicated that straw possesses excellent physical and constructional properties and that the tested wall construction achieves a passive house standard due to its good heat insulating qualities.

The planning and constructional implementation of the S-HOUSE demonstrate the fact that modern architecture and structural engineering can be ideally integrated with the principles of solar construction and the use of building materials derived from renewable raw materials.

The design related solutions developed for the S-HOUSE meet all requirements of the passive house standard with regard to heat conductivity and wind-proofing. All structural elements and designing offer a high degree of safety and user comfort because the use of non-toxic building materials and biologically unquestionable design. On the whole, no metallic components or synthetic material were used in the entire building. Only wood was used for the static construction.

According to results obtained from the fundamental studies, the facade was built as a structure made of wooden boards and straw bales that are pressed and mounted free of thermal bridging. This straw proofing was provided with a layer of clay plaster and a wooden casing. Wind-proofing is ensured by the wooden board construction. The south facade is fully glazed. Towards realisation of a passive house compatible building shell, the necessary straw bale proofed floor and ceiling elements were also developed. Thus, the entire building is "packaged" with straw and it provides optimum heat insulation.

The building stands on a sub-ventilated building slab, which is supported by individual footings. This facilitated a significant reduction in the use of mineral resources as compared to a conventional foundation; this construction also does not allow accumulation of cold and humid air in the floor slab area. This optimises the degree of insulation in the floor construction. The roof has been designed as a membranous roof, which is made of a "flying" wooden construction mounted over the straw insulated wooden ceiling and covered with a rubber membrane and greened.

In the S-HOUSE these innovative structures and building products are not only demonstrated, but their technical functionality is also constantly monitored.

For this purpose, an extensive measuring system has been developed to measure and document the important physical and climatic parameters of the building. Finally, the data obtained in the lab for the building construction are veryfied in practical terms.

On the north side of the facade, test wall elements are built into the straw/wooden construction where additional insulating materials made from renewable raw materials are used. This part of the facade is equipped with measuring sensors so that a comparison can be drawn between the wall elements and the rest of the building. For this purpose, insulating materials made of cork (Dämmkork/Qualitätsbaustoffe Bucher), hemp (Thermo Hanf) and flax (Hera-flax/Heraklith Dämmsysteme) were built in. Different measurements are continually evaluated and they will be available during the planned exhibition and over the Internet.

THE S-HOUSE: INFORMATION AND EXHIBITION CENTRE

The S-HOUSE acts as a centre for renewable raw materials and sustainable technologies in the field of building constructions. The functionality of building materials made from renewable raw materials is proven on the building itself. The components and designed structures developed for the S-HOUSE are presented for public view in a permanent exhibition. Moreover, the basic information on "Sustainable Construction" provides a comprehensive overview of a wide range of applications using renewable building materials. As a result, traditional know-how and recent developments in this field become accessible to a large section of the public. Besides the permanent exhibition, technically related events such as symposiums and advanced learning sessions with university student participation and practical orientation are also planned.

The S-HOUSE forms an important part of the theme park "Sustainable Technological Development" planned on site in Böheimkirchen. Surrounding the building is a show-cased garden that is conceived as a "material garden" which will exhibit where and how natural building materials that are used in the S-House actually come from. Trials for extended structures and suitable materials for ecological garden landscaping (fences, path, facings, etc.) are also exhibited here.

The S-HOUSE serves as a turntable of information where contemporary know-how sourced from research and practice is collected, processed and distributed. An important aspect of the information is the INFOKNOTEN www.nawaro.com that is created within the scope of the "Building of Tomorrow". Here more than 400 of the most important products made of renewable raw materials are collected, sorted into different categories of building materials and described according to their technical and ecological properties. The INFOKNOTEN endeavours to create a network of manufacturers, building contractors, government agencies, architects and consumers and, to promote the use of renewable raw materials and ecological materials in the building market.

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

S-HOUSE
Innovative utilisation of renewable resources as exemplified in an Office and Exhibition Building

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INFORMATION PUBLICATIONS

The final report on the above-mentioned study has been published by the Austrian Federal Ministry of Transport, Innovation and Technology (bmvit) in the series of articles "Reports on Energy and Environmental Research" in its issue of 2/2005. It is also available at:
www.NachhaltigWirtschaften.at

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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: GrAT – Center of Appropriate Technology/Vienna University of Technology, 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.