Federal Ministry of Economics and Technology

Federal Ministry of Transport, Building and Urban Development

dasHAUS

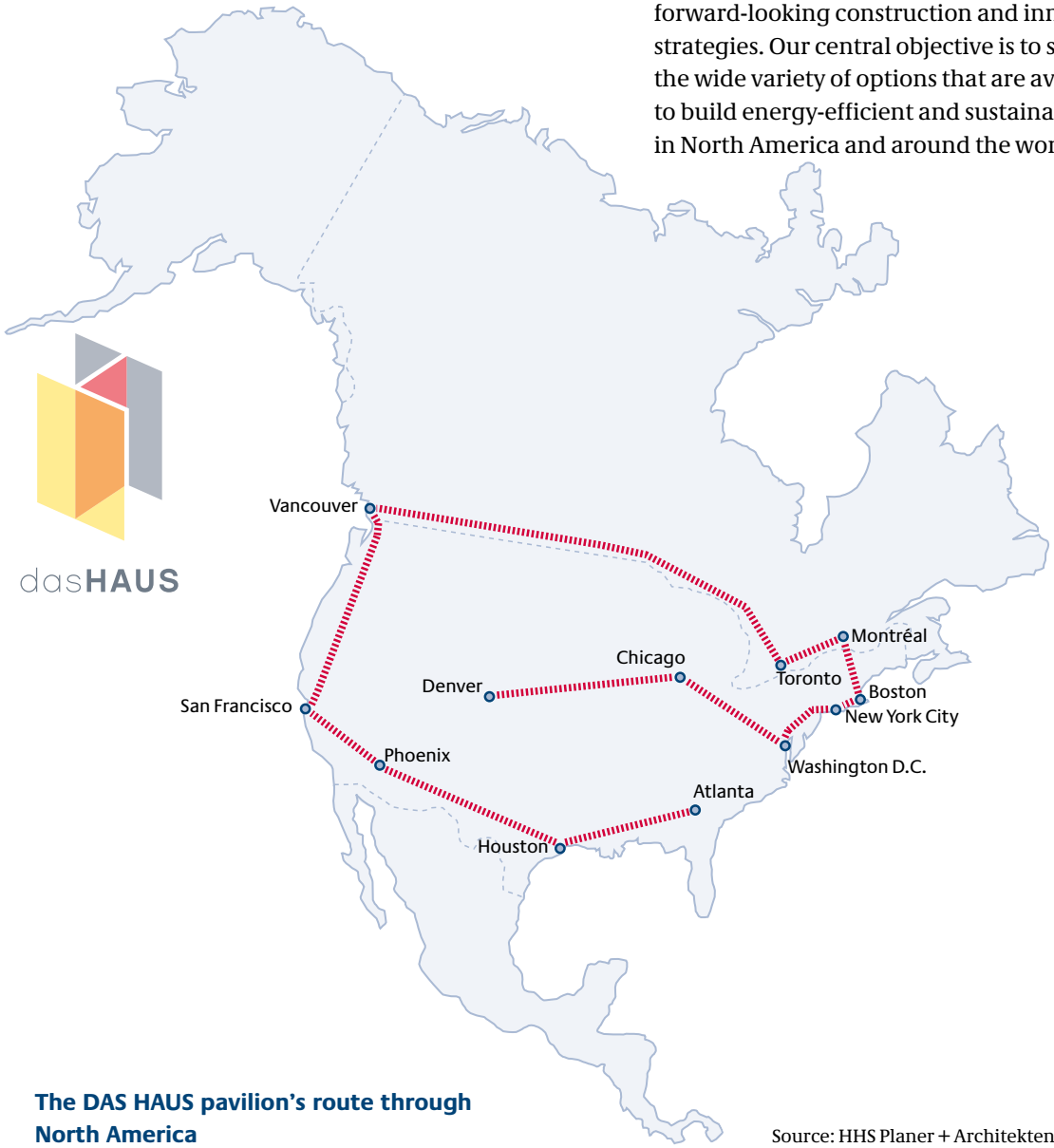
DAS HAUS: Innovation in Renewables and Energy Efficiency

Preface

DAS HAUS is a traveling pavilion that showcases cutting-edge architectural and technical concepts for maximizing energy efficiency and the use of renewable energy in construction. This mobile exhibition is supported by the German federal government's Ministry of Economics and Technology and forms part of two export initiatives run by the Ministry: the Renewable Energy Export Initiative and the Energy Efficiency Export Initiative. In-depth information on these initiatives can be found online (in English) at www.efficiency-from-germany.info and www.renewables-made-in-germany.com.

By putting the pavilion on the road throughout the United States and Canada, the export initiatives are specifically targeting specialist audiences in North America. The aim is to demonstrate innovative possibilities for using renewable energy sources to operate buildings, and to show how construction and technology can be combined sensibly to boost energy efficiency and energy savings.

Starting in October 2011, the DAS HAUS pavilion will be on display in nine cities in the United States and three cities in Canada over a total period of 13 months. These venues will provide a platform for disseminating German industry's know-how when it comes to forward-looking construction and innovative energy strategies. Our central objective is to show visitors the wide variety of options that are available today to build energy-efficient and sustainable bulildings in North America and around the world.



The DAS HAUS pavilion's route through North America

Source: HHS Planer + Architekten AG

DAS HAUS: Origins

Winning design: 2007 Solar Decathlon
Source: Leon Schmidt

Winning design: 2009 Solar Decathlon
Source: Thomas Ott, www.o2t.de

Germany is known around the world for the high standards of its technical and industrial systems and products. The words “Made in Germany” and “German Engineering” invoke thoughts of innovation and dependable quality. This is also true in the fields of renewable energy, energy efficiency technology, and energy consulting, where Germany has established itself as an international market leader and innovation driver.

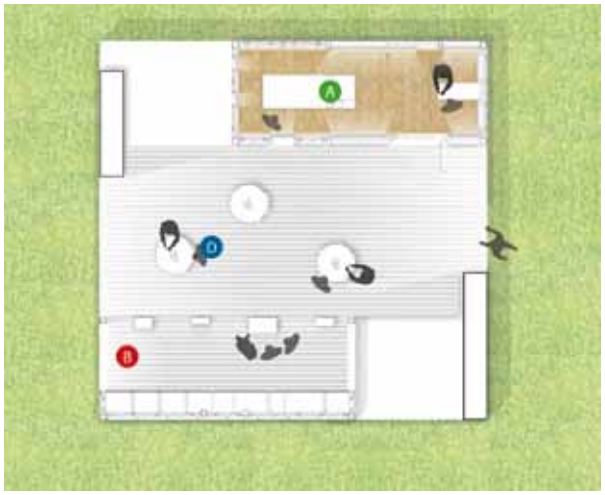
DAS HAUS draws its inspiration from the Technical University of Darmstadt’s two winning entries in the Solar Decathlon, an international solar house competition presented by the US Department of Energy in which 20 collegiate teams from around the world design, build and operate solar-powered houses which are cost-effective, energy-efficient and attractive. The Technical University of Darmstadt has won first prize twice – in 2007 and 2009 – under the direction of Prof. Manfred Hegger, who in partnership with his wife Doris Hegger-Luhnen designed the DAS HAUS pavilion.

In order to demonstrate that energy efficiency and renewable energy can go hand-in-hand with first-rate quality and aesthetics, DAS HAUS was conceived on the basis of these award-winning designs while simultaneously taking into account the challenges associated with transport and repeated assembly and disassembly during the road show throughout North America.

At the same time, the concept for DAS HAUS is tailored to the specific requirements of construction and residential living in North America. For example, the structure places a particular emphasis on the use of solar power, because this form of renewable energy is relatively easily available in many regions of the United States and Canada.

I. Architecture and technology

Cross-section view of the DAS HAUS pavilion
Source: HHS Planer + Architekten AG



Floor plan of the DAS HAUS pavilion
Source: HHS Planer + Architekten AG

- A Element 1: Enclosed room (Container A)
- B Element 2: Technology component (Container B)
- C Element 3: "Floating roof" connecting the enclosed room and technology components A and B
- D Public gathering area with informational displays

DAS HAUS demonstrates that aesthetics and comfortable living can go hand-in-hand with energy efficiency and renewable energy. Here, the building and its technical systems join together to form an innovative total system. Sophisticated architectural design and green technology are tailored to everyday needs and energy requirements.

Visitors to the pavilion are treated to direct, tactile experiences with sustainable architecture and technology as reflected in construction methods, materials, and technical systems. They are literally able to "grasp" the connections between technology and materials, including elements that are often hidden under the surface of conventional buildings.

Construction

DAS HAUS consists of three structural components: an enclosed room "living space" component (Container A), a "technology" component (Container B), and a "floating roof" that connects these two components while providing a covered area that forms the pavilion's public "meeting space".

The "living space" component is conceived as an enclosed room. Its super-insulated envelope is designed in accordance with Passive House standards, which means that in many climate zones the building requires little to no external energy input throughout the entire year. The built-in technical systems provide examples of passive and active solutions for energy-efficient construction.

The pavilion's "technology" component opens up to the roof-covered public meeting area and features material models of various strategies for energy-efficient construction. These include lightweight and concrete/masonry wall structures with excellent insulation properties as well as energy-producing walls. Building envelopes in particular play a key role when it comes to energy performance.

The pavilion's solar power is generated by photovoltaic modules installed on the structure's roof, wall surfaces, and sun control louvers. This solar power, which is produced "free of charge", supplies the building's electricity and functions as a stand-alone system for DAS HAUS. This type of solution is particularly suited for buildings in remote locations. The system controls and storage batteries are compact enough to fit into cabinets located in Container B. It is also possible to connect the system to the power grid. The climate control technology is simple and de-

www.sunnyportal.com
Sunny Portal is an online service provided free of charge by the SMA Solar Technology company that allows users around the world to monitor the operating data of individual photovoltaic installations. Using easy-to-understand graphs and tables, the service analyzes the energy performance of individual installations and provides useful data such as information on CO_2 savings. Regular e-mail status reports let users know if their systems are functioning smoothly. In addition, an iPhone app that can be downloaded from the Sunny Portal website enables users to access this service from anywhere at any time.

Public gathering area between the living space and technology component
Source: Hochtief ViCon GmbH

signed in a way that is easy for visitors to understand. The photovoltaic system's real-time energy yield can be checked online or viewed on a monitor like the one installed in the pavilion. There is also a smartphone app available for monitoring real-time energy yields.

The public gathering area, located between the pavilion's living space and technology components, is accessible from two directions and provides a covered space for events. Various samples and models are exhibited here in display cases. The protective roof that covers the area measures about 32 x 32 feet (10 x 10 meters).

II. The DAS HAUS energy concept

DAS HAUS – Living space component: exterior view
Source: Hochtief ViCon GmbH

The design of DAS HAUS ensures that as little energy as possible escapes through the building envelope and that the building's low energy requirements can be met by the technical systems integrated into the structure. By combining passive (low-tech) and active (high-tech) technologies, DAS HAUS serves as a model that demonstrates the great potential for using renewable energy sources and maximizing energy efficiency.

Active and passive technologies

Photovoltaics

Photovoltaic systems are already a common feature in many buildings as a way to provide an environment-friendly, efficient energy supply. The DAS HAUS pavilion's stand-alone installation employs various photovoltaic systems that are integrated into the building itself. The energy generated by these systems either powers the pavilion directly or stores energy in the battery units to provide power well after dark.

Photovoltaic louvers

The pavilion's photovoltaic louver system is based on the design developed specifically for the 2007 Solar Decathlon house. Wooden louvers affixed with CIS thin-film photovoltaic panels perform a dual function by collecting solar energy while simultaneously shading the interior from over-exposure to sunlight. Exterior shading devices offer a simple and cost-effective solution for reducing a building's cooling load by preventing excess sunlight from heating the interior.

Photovoltaic roof

The pavilion's roof incorporates CIS thin-film photovoltaic modules embedded in glass to protect the cells from damage due to water infiltration. These

What is CIS?

CIS thin-film photovoltaics (TFPV) offer enhanced flexibility in solar energy collection. Copper, indium and selenide (abbreviated CIS) combine to form a thin and efficient semiconductor which can be applied either to a glass or flexible plastic substrate. The CIS TFPV's shade-tolerant cell structure performs well even at higher temperatures and in ambient light conditions. Due to their flexibility in application, CIS TFPV are ideal for building-integrated photovoltaic systems such as those incorporated in DAS HAUS.

External view: PV wall module
Source: Hochtief ViCon GmbH

modules perform well even at high temperatures and low-light conditions due to the chemical properties of the CIS compound.

Photovoltaic facade

The pavilion's photovoltaic facade consists of eight equal-size modules that combine solar panels with a facade insulation system. This system demonstrates solutions that can be used for both energy efficiency retrofits and new construction.

Vacuum insulation panels (VIPs)

Vacuum insulation panels (VIPs) are a high-performance thermal insulation system comprised of a reflective high-barrier foil membrane wall encasing a rigid core within a nearly gas-tight space. VIPs achieve outstanding insulation performance by curbing the three forms of heat transfer: convection, conduction and radiation. Near-vacuum conditions reduce the convection and conduction of heat, while the reflective high-barrier foil membrane deflects long wavelength radiation. VIPs are up to ten times more efficient than traditional insulation types, yet can be up to ten times thinner. They are ideal when space saving is essential and high insulation performance is desired, such as the envelope of the enclosed room at DAS HAUS, which features two offset VIP layers in the walls, floor and ceiling of the container, as well as the entrance door and ventilation window.

Windows and ventilation

The pavilion features fixed, floor-to-ceiling windows with insulated oak frames and triple-pane glass with a low-e coating. This allows for excellent thermal and sound insulation while simultaneously providing plenty of natural daylight in the room. Ventilation is provided by an insulated ventilation window adjacent to the fixed windows.

What is inverter technology?

Inverter technology reduces compressor rotation speed to save energy and minimize temperature fluctuations. Heating and cooling output are continuously adjusted to current conditions. As a result, target temperature levels are reached more quickly and then remain stable, enhancing both energy efficiency and comfort.

Mechanical ventilation

The compact climate control unit – which features both sound and thermal insulation – is located in the enclosed room living space component. This unit is supplemented by an external inverter split heat pump unit that functions as an inverter-driven compressor. Climate control is regulated by room temperature sensors and an automatic control system. Fresh air from outside is brought in via an intake duct located on the roof of the container and passes through a filter, and stale air is exhausted near the floor. These two air streams then pass through a heat exchanger, which recycles the thermal properties of the interior air by pre-heating or cooling the fresh air as needed. This optimizes heating and cooling output even when outside temperatures are especially high or low. This type of climate control system efficiently provides high-quality indoor air comfort year round.

Lighting technology

The dimmable internal lighting system allows for a wide range of light settings. LED technology makes the system extremely energy-efficient, so that the necessary electricity is easily supplied by the pavilion's integrated photovoltaic system.

Household appliances

The pavilion also contains energy-saving appliances – including a refrigerator and coffee maker – ideal for hosting events at DAS HAUS. This mini-kitchen demonstrates that full functionality is possible within a very small space and with minimal energy requirements, which are also fully covered by the house's self-generated solar power.

Technical data

Gross surface area/roof	ca. 883 ft² (82 m²)
Gross surface area/deck	ca. 409 ft² (38 m²)
Exhibition area	ca. 646 ft² (60 m²)
Net floor area/Container A (enclosed room)	ca. 118 ft² (11 m²)
Net floor area/Container B (technology container)	ca. 108 ft² (10 m²)
Gross volume	55 yd³ (42 m³)

Heating, air conditioning and ventilation: supplied by a compact climate control unit combined with an inverter split heat pump

PV elements/roof	ca. 97 ft² (9 m²); yield 1.05 kWp
PV elements/wall	ca. 65 ft² (6 m²); yield 0.50 kWp
PV elements/louvers	ca. 108 ft² (10 m²); yield 0.34 kWp
Total yield	approximately 1.89 kWp

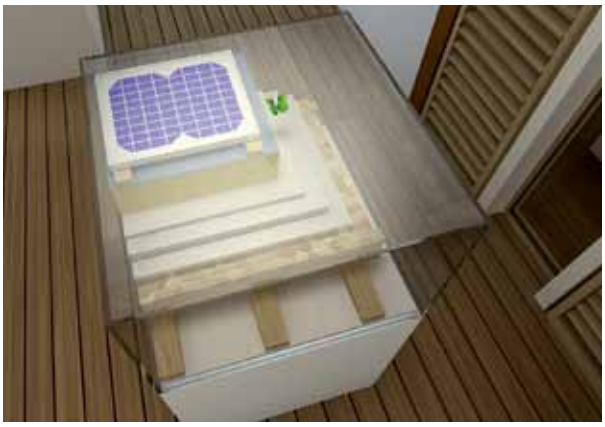
Ventilation

- → Natural cross-ventilation (ventilation window)
- → Mechanical ventilation: supplied by a compact climate control unit combined with an inverter split heat pump

Materials

- → Renewable materials (wood, oak)
- → All materials are recyclable

Living space component: interior view
Source: Hochtief ViCon GmbH



Display case samples (varies by location)
Source: Hochtief ViCon GmbH

Display case samples (varies by location)
Source: Hochtief ViCon GmbH

Energy concept

Minimize energy demand

- → retain heat through a compact structure and super-insulated envelope

DAS HAUS – wall construction cross-sections
Source: Hochtief ViCon GmbH

Wall Section 1	Composite Heat Insulation System
	Interior plaster
	Cellular concrete block (6.9 in / 175 mm)
	Polystyrene insulation (3.9 in / 100 mm)
	Thermal insulating plaster Exterior plaster
Wall Section 2	Container Wall
	Drywall (painted)
	Furring strips (2.4 x 1.6 in / 60x40 mm)
	Vacuum-insulated panels (2 layers) Purenit lathe (0.08 x 1.2 in / 2x30 mm)
	Corten steel sheet (0.08 in / 2 mm)
Wall Section 3	Solar Decathlon 2007
	Drywall (painted)
	Wood posts
	OSB panels (0.79 in / 20 mm)
	Vacuum-insulated panels (2 layers)
	Eternit fiber cement curtain wall
	Wood louvers
Wall Section 4	Environmentally Sustainable
	Clay-based interior plaster
	Three-layer composite wood (0.63 in / 16 mm)
	Rafters with cellulose fiber insulation (5.5 in / 140 mm)
	Clay-based exterior plaster

- → for cooling purposes, use thermal insulation to prevent overheating
- → use cross-ventilation to provide natural ventilation
- → maximize available natural light
- → save energy by using energy-efficient household appliances and technology

Optimize energy supply

- → heating: use renewable energy sources efficiently; passive solar power generation
- → cooling: compact climate control unit cools warm temperatures efficiently
- → energy-efficient mechanical ventilation
- → lighting: energy-efficient LED lighting technology provides equivalent luminous efficacy at lower levels of electricity consumption
- → active power generation through photovoltaic systems on roof, walls, and louvers

The didactic concept of DAS HAUS: experience – learn – touch

The DAS HAUS pavilion is designed as an exhibition that engages visitors in three key activities. First, visitors **experience** the technology and materials through the medium of architecture, allowing for a deeper engagement in and understanding of the techniques on display. Second, guided tours and additional printed information enable visitors to **learn** about the technologies, materials and construction methods used in DAS HAUS. In this way, visitors – both specialist and non-specialist – gain greater insight into the current German approach to energy-efficient construction and how these techniques can be applied in North America. Third, visitors are able to **touch** what they see. To this end, the pavilion also exhibits a variety of technologies that for technical, functional, or spatial reasons could not be integrated into the building envelope. These are presented in additional wall displays.

Additional objects that visitors can touch and hold are exhibited in additional display cases.

This tactile experience aims to make visitors more familiar with – and thereby to demystify – the technology that can be used in energy-efficient buildings.

dasHAUS

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