Technische Universität Darmstadt

"Made in Germany" is a phrase that applies well to the Solar Decathlon entry from Darmstadt. The team members want to present the German way of building, showcasing German technologies and materials in their solar house. The house is built to be comfortable and adjustable to the user's demands. The design concept is to integrate energy efficiency within the architecture, preferably using "passive" or traditional methods. At the same time, active methods for energy production and conservation that incorporate high-tech materials and technology are used to provide a high standard of life.

What's Different?

- Like the skin of an onion, the building is configured in layers that control different functions. Outside, a layer of wooden louvers provides shading and privacy protection and simultaneously generates electricity through integrated PV. The second layer is the thermal envelope, consisting of opaque, vacuum-insulated walls on the east and west sides and highly efficient, floor-to-ceiling windows on the north and south sides. The third layer is the central core, in which all vertical technical installations and the private facilities are bundled. It is designed to use minimal space and allow maximum comfort by being adjustable in size and appearance through movable and illuminated walls and components.
- All technology is integrated into the architecture—serving multiple functions both as building components and to conserve or generate energy. From the beginning, energy efficiency along with aesthetics, evaluated and selected through computer simulations, have been key issues in the design process.
- The building is made of traditional, renewable, and/or local materials, such as German oak. These materials were selected based on their material properties or because they provide timeless, simple aesthetics. Both in the approach of energy conservation and architectural integration, and in the preferential use of German-manufactured products, the students from Darmstadt want to present a "Year 2015 Protoype Home—Made in Germany."

Architecture, Interior Comfort

- The building is designed to provide maximum comfort and user flexibility along with reduced energy demand and maximum, building-integrated energy production.
- The building consists of three equal-sized modules, which can be transported on a truck, allow in-fill for a bigger footprint, and lend themselves to prefabrication and easy relocation. Based on its high-performance energy concept, the house is suitable for almost any climate zone.
- To maximize space and flexibility of use, the interior space is arranged in zones, rather than in different rooms.
- All building systems can be either automatically and user controlled. Humans control the technology, not vice-versa.
- The house is designed to provide a modern lifestyle along with the capacity to experience the outdoors during various times of day and seasons of the year.

Heating and Cooling Systems

- As a "passive house," the building features a highly insulated thermal envelope and relies mainly on the use of solar irradiation through the south-facing windows and interior gains for heating; it requires only 15 kWh/m²/year for space heating (the average of the German building stock requires about 200 kWh/m²/year and new construction in Germany about 60kWh/m²/year).
- To prevent overheating, the building features a roof overhang in the south and is surrounded by an envelope of louvered shutters, allowing both cross ventilation and privacy. Thermal mass, which is provided through phase-change materials and is integrated in the east and west walls and the ceiling, buffers temperature swings. This system is complemented by a radiant-cooled ceiling (based on evaporative cooling of water that is pumped over the roof and collected at night).
- For extreme weather, when these systems may not be sufficient, there is a reversible heat pump, which can heat and cool the air, capture energy from the waste air, ventilate the space, and use excess energy to heat water for household purposes and to heat the bathroom floor.

Lighting (including Daylighting)

- Floor-to-ceiling windows are on the north and south sides allow generous daylighting (quadruple glazing-north, triple glazing-south, insulated frames). Shutters and windows can be operated manually, extending and limiting the living space, according to daytime, seasonal, and user demands.
- The electric lighting design also focused on architectural integration, providing general, ambient, and task lighting. To reduce energy consumption, the type of lighting used was matched to the task (compact fluorescents for general and ambient lighting, halogen for task lighting, and LED lights both for ambient and general lighting).

PV and Solar Thermal

- The house features three different kinds of photovoltaics: monocrystalline silicon, highly efficient SunPower modules on the flat roof: monocrystalline, translucent, glass-embedded Sunways cells for shading and protecting the south porch, and Schott amorphous-silicon modules, which are integrated into the wooden facade louvers on the east, south, and west sides of the building and which follow the sun through automatic controls and generate electricity while the building is shaded by the louver shutters.
- Bosch-Buderus flat-plate solar thermal collectors complement the heat pump by heating water in an integrated hot water storage tank.

Communications

- One important goal of team's communications efforts is to demonstrate that modern demands on comfort and lifestyle can be met by building-integrated energy production and energy-efficient architecture.

Budget

- See PDF at www.solardecathlon.de for details.

Future Plans

- After its return to Germany and display at the building fair (DeuBau) in Essen in January 2008, the house will be reinstalled on campus in Darmstadt and serve as living laboratory and headquarters of the university's project that involves equipping the campus with building-integrated photovoltaics via shared investments of the university community.

Kid's Corner

- The building can shade itself and stay cool by closing the shutters—just as you wear a hat in the summer.
- The thermal shell, which can close to keep the heat in or can open up to allow air flow through, is like your clothes, which are thicker and closed in winter, and lighter and can be opened up in the summer heat.

Team Information

Technische Universität Darmstadt (Darmstadt University of Technology) is one of the oldest and most renowned polytechnical universities in Germany. Darmstadt is known as the "the city of sciences" and for the Mathildenhöhe, an art nouveau artist's colony that was founded at the turn to the 20th century. It is located in the state of Hesse, just 20 miles south of Frankfurt.

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