Summary Report

TECHNISCHE UNIVERSITÄT DARMSTADT

SOLAR DECATHLON 2009
TEAM GERMANY

“Design, Construction, and Competition-mode of an energy-gaining prototype for future living in 2015 within the Solar Decathlon 2009“

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FORSCHUNGSINITIATIVE Zukunft BAU

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1. Targets of the research project

The Climate Change, increasing energy consumption and expiring natural resources are demanding more attention not only for the use but also for the construction of buildings.

Actually, the building sector is exploiting most of the natural existing resources. Therewith sustainable building design needs to play a major role in order to conserve the remaining resources. Sustainable building means to reduce land consumption, to minimize the energy consumption for production and to minimize energy needs for living. The belongings of further generations have to be satisfied and long lifecycles must be guaranteed while using renewable resources. Against this background, the Solar Decathlon is hold. The Competition faces one of the biggest challenges of mankind, the need for an ecologically sound energy use in building. As an internationally recognized event it aims to strengthen the necessary development by heading for several goals:

1. Educating the student participants as to the benefits of energy efficiency, renewable energy and green building technologies.
2. Raising awareness among the general public about renewable energy and energy efficiency, and how solar energy technologies can reduce energy.
3. Helping solar energy technologies enter the marketplace faster.
4. Fostering collaboration among students from different academic disciplines.
5. Promoting an integrated or “whole building design” approach to new construction.
6. Demonstrating to the public the potential of Zero Energy Homes, which produce as much energy from renewable sources as they consume.

The competition offers a unique option for international exchange concerning solar, energy efficient and sustainable building design. As the only German participant surPLUShome represented

the advance of German technologies and high-quality design on the National Mall to a wide-spread international public. A special aspect of the project is to connect teaching and research development. The building has been entirely designed and realized by the student’s team. Students – multipliers of today and tomorrow – were introduced to the topics of energy efficient and sustainable Building Design and to „how to realize a visionary, self-sufficient prototype living home“?

2. Development and competition time

2.1. The “Solar Decathlon“

Solar Decathlon is a competition in which 20 teams of college and university students compete to design, build, and operate the most attractive, effective, and energy-efficient solar-powered house. It is also an event to which the public is invited to observe the powerful combination of solar energy, energy efficiency, and the best in home design. The Solar Decathlon is an international competition run by the U. S. Department of Energy. The aim is to build a Zero Energy Home, which produces as much energy from renewable sources, as it consumes.

Just like the Olympic decathlon this competition consists of 10 contests that centre on all the ways in which we use energy in our daily lives. The 10 contests are: Architecture, Market Viability, Engineering, Lighting design, Communications, Comfort Zone, Hot Water, Appliances, Home Entertainment and Net Metering.

In 2007 Darmstadt University of Technology took part as „Team Germany” for the first time in the Solar Decathlon and was able to win this competition. Succeeding the team of 2007 we will all have to match with prominent internationally respected competitors in 2009. The 2009 Solar Decathlon tries to answer the question, if plus energy homes are possible within a grid-tied dwelling.

Solar Village of Solar Decathlon 2009 in Washington DC (Photo: John Paltrera, DOE)

During one and a half years 25 students of the department of Architecture and Renewable Energies took their chance, to develop

a project from the first sketch to its realization. After an intensive time of planning and fabrication, Team Germany was able to present their surPLUShome on the National Mall in Washington DC. The competition as well as architecture itself is demanding a high degree of interdisciplinarity. Taking part at the Solar Decathlon has been a unique possibility for our students to experience this interdisciplinarity practically and to learn with and from this background for their own future.

3. Team Germany's surPLUShome for Solar Decathlon 2009 – Innovations of the house

3.1. Architecture, Engineering and Technologies of surPLUShome

The surPLUShome introduces the concept of energy efficiency and sustainability as surplus in everyday life. The building features many elements allowing the user to break common stereotypes of living concepts and to generate a new lifestyle. As a pun, sur+ allows to integrate all these different building elements or building aspects and to make them an integral part of surPLUS.

The surPLUShome grows with its inhabitants in an adequate and non-obtrusive manner. The flexible and open space surprises, it can deal with many different demands. Individually the user can decide which elements might be suitable and applicable to his or her lifestyle. The house makes it available to a wide audience; it is adjustable to changing life sequences and environments.

Building services introduce the idea of low exergy technologies and surpass therefore common systems.

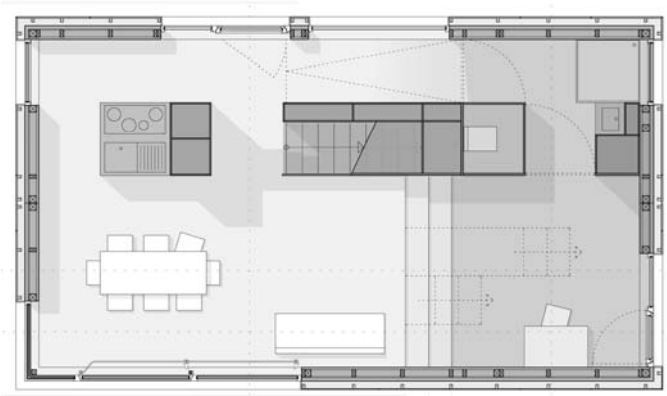
3.1.1. Architectural Concept

The design of our house aims at creating a maximized living space, a maximum energy surplus, at the same time trying to adapt to the environment. To achieve these goals, we have placed a

multifunctional space within the maximum cubature providing high flexibility. The bedroom space with an open gallery above creates a cosy atmosphere; the gallery offers extra space for cocooning and leisure. The multifunctional spine is the heart piece of our interior design; it accommodates the kitchen, building services and furnishings and plays an important role in defining different atmospheres and zones. This allows for an open and flexible living room. The spine has a glossy white acrylic glass surface, which can be coloured by LED-Lights.

Our house offers multifaceted one room living space made up by a public and a private area that can be adopted by the user according to his or her needs.

Photo: Interior space of surPLUShome
(Foto: Thomas Ott)

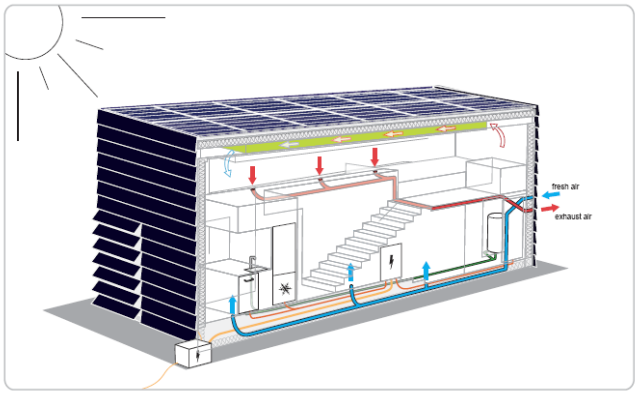


Drawing: Floor Plan of surPLUShome
(TU Darmstadt)

Sustainable architecture is not about saving or producing as much energy as possible. Ecological, economical and social aspects need to be considered with convenience of the inhabitant in its centre. Therefore the aims and ideas in the planning process have to be challenged and verified again and again. The Solar Decathlon competition process lends itself to this careful and thorough planning procedure.

surPLUShome is a contribution to sustainable showing the liveability and beauty of a sustainable house. Sustainable houses are a major lifestyle element in the future.

3.1.2. Energetic Concept



Drawing: Thermal System of surPLUShome (TU Darmstadt)

The house pushes energy efficiency to the current limit. It combines a high level of comfort with intuitive building control, energy saving and energy producing systems and, above all, aesthetic pleasure. The technical systems applied are integrated in a coherent design to surpass common technical and architectural functionality.

Therefore passive, active and low exergy technologies need to interact. Passive systems reduce the energy demand; active systems cover this demand effectively, creating a good surplus. Low exergy technologies activate ubiquitous energies.

To reduce energy demand, the building envelope is highly insulated and airtight made of Vacuum-Insulation-Panels or triple-glazing. For the reduction of heating and especially cooling loads, we have integrated phase change materials inside the gypsum wall cladding and into the cooling system in the ceiling. It buffers temperature peaks effectively.

Appliances with low energy demands and reduced needs for primary energy round up our surplus strategy.

Photovoltaic systems are integrated into the building surface. Our façade is multifunctional and covers many requirements. A goal of our design was to achieve a homogenous and innovative façade without neglecting building practice. The construction of

the façade is based on the traditional principle of shingling. The installed PV-modules shall collect twice the energy needed. We use two different efficient PV-technologies: mono crystalline silicon modules with an efficiency of 18 % on the roof; thin-film CIS modules with an efficiency of 11 % on the facade. Even though these cells have a lower efficiency, they have fewer problems with increasing temperature and have a better performance in cloudy weather situations.

As first image of the building, the façade stands for a new, energy efficient lifestyle.

3.1.3. Sustainable engineering

A sustainable engineering should centre human needs as main goal. The energetic performance in operation is one aspect of sustainable design. Building causes as well a high-energy use for production of the building itself. A life cycle assessment of the surPLUShome in building and operation revealed that the building produces all the energy necessary for its production within 11 years. It takes only 10 years to cause negative CO_2 emissions, as many building elements supply a high range of functions. The true innovation lies in the combination and integration of multiple elements with each other.

The value of sustainable design is at last, that the user knows that he is able to contribute to a sustainable future on many levels just by living – a new way of comfort.

For further information see: www.solardecathlon2009.de