Substainability

Sustainability Brief Report

TEAM IKAROS BAVARIA

SOLAR DECATHLON EUROPE 2010

sd europe SOLAR DECATHLON

POLITÉCNICA

MADRID

GOBIERNO DE ESPAÑA MINISTERIO DE VIVIENDA

U.S. DEPARTMENT OF ENERGY

SOLAR DECATHLON

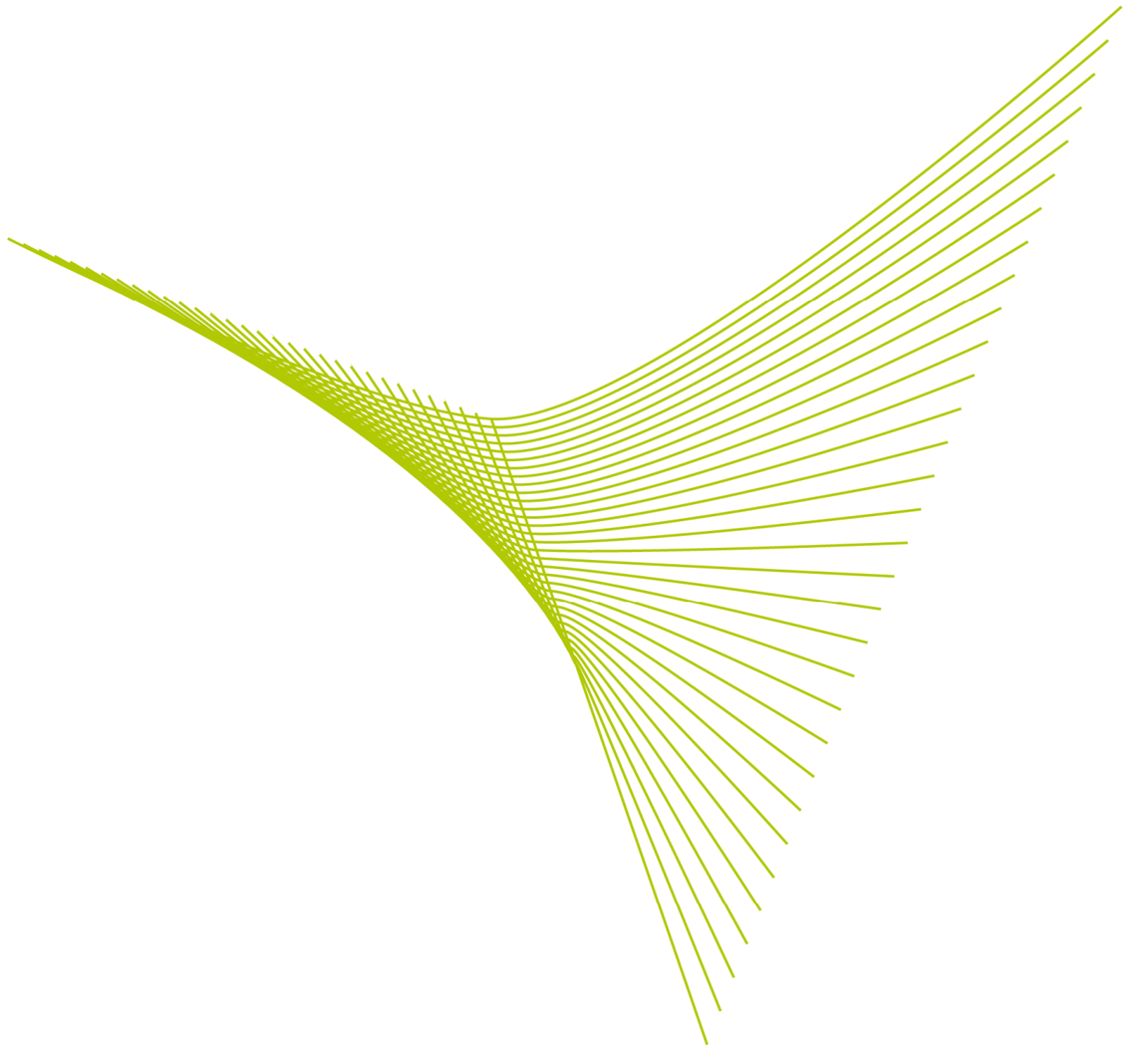


Table of contents

1. Sustainability concept

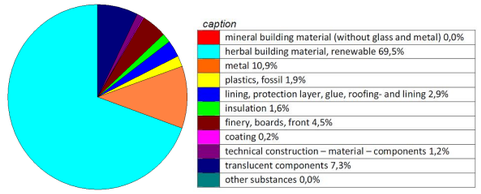
Our original aim when designing the building was the first-time application of the concept of the German Seal of Approval for Sustainability (DGNB) to smaller residential buildings. But as this certificate was designed only with non-residential buildings in mind, it cannot be applied to residential buildings in all its aspects. At the same time we had to comply with the requirements as determined by the rules & regulations and to document how we achieve this aim. After talks with the German Association for Sustainable Building it became clear, that the seal of approval could not be assigned to buildings without a fixed location, because the location is also a relevant factor for the evaluation. Moreover, the benchmarks (e.g. for the evaluation of the ecological quality) cannot just be transferred to a residential building, because they have been developed for non-residential buildings comprising much bigger spaces. Thus, we had to decide between the rules and the seal of approval. From this point on, we primarily focused on complying with the requirements as determined by the rules & regulations and on documenting our approach. Moreover, we have been collecting data during the entire project in order to be able to carry out a life cycle analysis according to the DGNB.

2. Reuse of the building

One of our major concerns was to ensure the reuse of our building. Already for several years, the University of Rosenheim has been working on an ambitious project in cooperation with a service company from the real estate industry: the Zero Energy Town. The grounds, on which this town of the future is to be erected, is a former military grounds and is supposed to be energy self-sufficient. The location on this ground is an ideal site for the house and supports the project concept. It is to be constructed near a hotel complex and to be rented out to interested visitors of the Zero Energy Town. The building permit has already been obtained. As the ground is located only a few kilometers away from the university, it will also be accessible to the students of the University of Rosenheim and of other universities. In addition, an elaborate energy monitoring is planned.

3. Sustainability with regard to architecture

Calculations and simulations show that - thanks to an optimized ventilation - a relative humidity of over 55% occurs inside the building only on about 15 days of the year. This means that to comply with the rules and regulations approximately 50kg of water per year have to be dehumidified, when an optimized ventilation is assumed. Approximately 150 kg of water per year have to be supplied. As an active dehumidification entails a considerable technical and energetic effort, we have decided to use passive measures for humidity regulation. Originally the use of clay building boards was planned in the interior. However, because of the high deadline pressure during the manufacturing process we have decided against an installation. Instead of clay building boards a natural limewash paint, which is very favorable from the hygric point of view, has been applied to the gypsum fiber board as a coating. This surface layer helps to regulate the humidity concentration in the interior. We are also attaching great importance to the integration of our house into either existing or new, still to be developed urban structures. Here, we found that the flexibility of the building offers an endless number of options and variants for integration - not least because the modular concept offers many future possibilities.



Material fraction

4. Sustainability with regard to construction and engineering

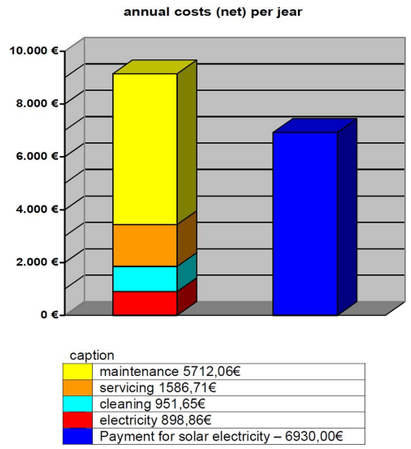
As for our water concept, an analysis of the measured water consumption values provided by the Federal Statistical Office showed us that it is mainly the user him or herself who can achieve a minimization of fresh water consumption. Thus, we suggest the user's training and sensitizing as a principal measure for saving water resources. Secondly, by installing household appliances and sanitary equipment of the latest generation we could reduce fresh water consumption by 50% compared to commercially available appliances. Fresh water requirement can be lowered by using rainwater. As it is not possible to accommodate a sufficiently big water cistern on the competition grounds, the use of natural water resources is restricted to radiation cooling. The water requirement can be easily covered with rainwater. The use of gray water, e.g. for flushing the toilet, can only be realized at the time the building will be erected in the Zero Energy Town. Installations for cleaning wastewater have turned out to be too large and unprofitable. The hygric quality of the building envelope is essential when it comes to the durability of the building. Therefore, we simulated the properties of the construction under very unfavorable hygric conditions for a period of three years using transient methods . (Heat and humidity transient „WuFi 2D" of the Fraunhofer Allianz Bau). The results show that no damages caused by excessive humidity loads are to be expected. Basic information regarding the amount of materials and waste to be expected during the construction process as well as for interior fittings can be found in the waste concept. Thanks to the high degree of prefabrication we can keep the amount of waste as low as possible. Approximately 80% of the waste consists of renewable materials. Some of these materials, like e.g. the hemp insulation, can even be composted. When dealing with household waste, we will practice waste separation. In this way, the organic materials can be composted and anorganic materials can be returned into the recycling circulation.

With our building we would like to demonstrate pioneering technologies in this field, like e.g. the innovative wooden main support structure and the resource saving lightweight building panels used in the interior. The composition of the house construction (not the total construction) is differentiated into renewable and non-renewable materials. Finally information about the necessary maintenance and cleaning work is provided. Our descriptions of sustainability with regard to construction and engineering have constituted the first step towards a life-cycle oriented building evaluation.

5. Ecological and economic quality of the building

In our opinion this chapter contains the future of the sustainability analysis of buildings. Here we try to describe all material streams and effects as exact and detailed as possible in the form of a comprehensive life-cycle analysis and life-cycle cost assessment. While the actual calculation of this gigantic amount of data was carried out by a sustainability expert (as this task requires much experience in the use of the program system), all elements, input data and material descriptions have been developed by the students themselves. For the life cycle assessment the complete life cycle of the building („from the cradle to the grave") has been regarded based on the method of the DGNB. In a life cycle assessment (LCA) all material and energy flows from the extraction of raw materials to the disposal of the building are regarded, also determining the associated environmental burden. The associated method is described in the criteria profiles 1-5, as well as 10 and 11 of the seal of approval. 7 environment indicators have been considered, e.g. greenhouse gas potential, ozone depletion potential, total primary energy requirement renewable and non renewable. The life cycle phases production, energy requirement, repair and disposal of the building have been considered. The eco-module database „Ökobau.dat" provided by the Federal Ministry for Transport, Building

and Urban Development (BMVBS) serves as the data basis for the calculation. The results of the life cycle assessment are partially negative, which means that a positive effect on the environment is created. This can be achieved through the approach of „saved expenditures“. So e.g. expenditures saved for the photovoltaics energy supply are credited in the nuclear power plant. Four of eight indicators show a negative balance – an excellent result. Additionally, we also consider the life cycle costs (LCC), meaning the degree of sustainability related to the economy of the entire building based on the method of the DGNB. Here, the following life cycle phases production, supply with and disposal of media, cleaning, maintenance and repair are regarded. The associated method is described in the criteria profile 16 of the seal of approval. Among other things, the cash value of the building after 50 years has been calculated. It rises from approximately 290.000 € at the time of the building's construction to approximately 335.000 € after 50 years. The return is about 14%. This is mainly due to an assumed rise of 4 percent in energy costs as well as the repair-friendly construction. The average annual costs are illustrated in the following diagram.



6. Sustainability with regard to solar systems

We have decided against the installation of a solar thermics system, as the waste heat of the heat pump can be used for heating the water. In this way the surface of the installed photovoltaics system (PV) can be maximized, as well. Thanks to the big photocoltaics surface and through regenerative power generation we can reach savings of about 145300 kg CO2 in thirty years of service life as compared to power produced in Germany. From the ecological point of view the cells will be amortized after 7,7 years. From the economic point of view an equalized balance can be reached after 12,2 years. The capital value is 32660€ after a service life of thirty years.

7. Sustainability with regard to the energy balance

Calculated over a year and assuming a normal use with ordinary user behavior (a power consumption of approximately 4300 kWh) four times as much power can be generated by the PV (16500 kWh). This results in surplus energy and thus an effective power input into the energy grid of 12200 kWh. This equals a total compensation for electricity fed into the grid of 6930 € per year. As during the competition the washing machine and other appliances must be used more often than would usually be the case, values will be higher than for normal use. Here, compared to consumption (218 kWh) only about three times as much energy (690 kWh) can be generated.

8. Sustainability with regard to comfort

The room temperature can be maintained within the required scope, i.e. at 25 degree Celsius, by using a ceiling cooling. Humidity is mainly regulated through the limewash coat, the cement fiber boards and pieces of furniture, and exceeds the admissible maximum only on 15 days of the year. The air quality, too, has been calculated. In the coming days

measurements will be carried out on-site to measure the actual VOC and formaldehyde content of the ambient air after a night without mechanic or natural ventilation. However, the results will only be available at the time of the competition in Madrid. As for illumination, we use almost no artificial light, because the building has many glass surfaces and a partially transparent sun protection. This sun protection is designed in such a way, that the room is not overheated while still being supplied with a sufficient amount of natural light. In the bedroom we used LCD technology, so that the glass panes can be switched from transparent to opaque as desired. In both cases the room is supplied with natural light, while at the same time providing protection from curious neighbors' glances. Night illumination is realized by using innovative LED technology, which consumes on average only about 100 W taking into account diversity factors. The reverberation period has been calculated according to DIN EN 12354 part 6. With 0,57 seconds at a frequency of 1000 Hz the calculated reverberation period stays just under the value of 0,62 seconds as required by DIN 18041. The sound insulation rate of the facade has been calculated according to DIN 4109 supplement 1. The resulting sound insulation rate of RW,R,Facade has been determined to be 36 dB. As because of cost considerations the facade could not be built true to original in our sound laboratory, we will be able to carry out on-site measurements only in the next days. The results will be published in Madrid.

9. Sustainability with regard to household appliances

Of course our positive energy balance is only made possible through the use of highly-efficient household appliances. But as the development of energy-saving household appliances is already highly advanced, we can only save 10 percent compared to currently available appliances.

10. Sustainability with regard to communication

We think that it is very important to inform the public about the insights and solutions suggested by the competition. Our house will be presented to visitors on major events such as the Horticultural Exhibition in Rosenheim or the international trade fair BAU 2011 in Munich. In addition we published newspaper articles, gave numerous radio interviews and created a documentation about the construction of the house in cooperation with a film team, which is to be broadcasted on German TV. But it is just as important that each participating student will be able to use the insights gained in this project in later profession life. In our case, the team was able to gain particularly profound insights, as the students have carried out this project independently from planning to actual construction. Each decision has been made, each plan drawn, each text written by the students alone. Even the construction of the house has been coordinated by the students to 100%. About 95% of the entire work from the manufacture of the fundaments to the installation of the roof cladding has been carried out directly by the students.

11. Sustainability with regard to industrialization

From the point of view of sustainability much is in favor of an industrialization. In this way considerably lower manufacturing costs and a constant quality can be achieved through a structured and monitored workflow. Another important argument for the customer is the shorter construction period, which is facilitated by consequent prefabrication and modularization. Through industrialization of the manufacturing process natural resources can be saved and waste can be recycled in a controlled way. The total amount of produced waste can be reduced by using made-to-measure components.

Hochschule **Rosenheim**
University of Applied Sciences

Sustainability Brief Report

Solar Decathlon 2010
Team IKAROS Bavaria

Hochschule für angewandte Wissenschaften
Fachhochschule Rosenheim / University of Applied Sciences

Hochschulstraße 1
83024 Rosenheim
Germany

May 2010

sd europe SOLAR DECATHLON · POLITÉCNICA · MADRID · GOBIERNO DE ESPAÑA MINISTERIO DE VIVIENDA · U.S. DEPARTMENT OF ENERGY · SOLAR DECATHLON