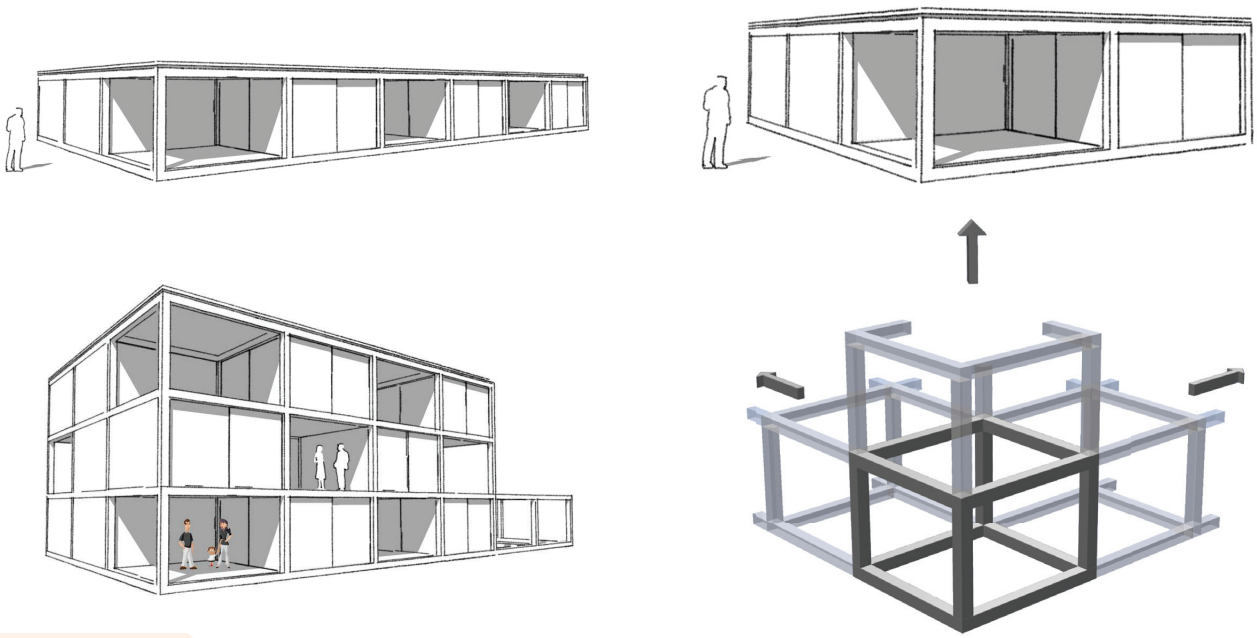
Architecture – Jury Report

The Philosophy of our Architecture

The ECOLAR architecture is based on a modular system with a 16m² cube as basis. Our analysis of residential living spaces over several eras has shown, that this size of rooms with a square floor plan offers the maximum flexibility in terms of utilization. The geometry allows both, the typical residential usage as living room, bedroom, dining, kitchen, guest rooms , sanitary facilities and so on, as well as alternative uses such as office workstations, conference rooms, recreation room, waiting room and so on for any changes in use (such as law office, doctors, call center, architects office et cetera). Therefore a basic infrastructure will be created for a long term of usage of the building, thus ensuring a high level of sustainability with regard to the use of resources.

Another important approach of ECOLAR is the possible extensibility (or reduction ability) of the concept in all three dimensions: length, width and height. Thus a building can be adjusted over the period of use, according to the new requirements. The statics of the developed support structure in the current version allows a three- to four-storey house, so that in addition to the pavilion, bungalow or atrium houses also row-houses or multi-storey-buildings can be realized with the ECOLAR architectural concept.



The Design Principle

The modular idea was also decisive for the design of the structure. After building the constructional grid out of columns and beams, various floor, roof and wall elements can be inserted into the supporting structure. Through this, the insulated hollow box sections and the surface elements form the energy-efficient thermal envelope of the building. Weather protecting cover panels on the outside of the supporting structure and a water-bearing energy-roof complete the building envelope.
The concept provides for façade elements which can be selected from a wide range of different visual and technical characteristics. For the SDE 2012 three types of facades (translucent, transparent and opaque) were chosen:

Type 1:
fully glazed transparent elements provide a very good daylighting and relate the interior to the exterior. Due to a special sliding technique the facades open wide and the outer space can be connected to the interior.

Type 2:
Newly developed translucent elements form an attractive room structure with diffuse daylighting. Filled with a special fleece and wooden slats the facades are optimized for south or north sides with a focus on daylight transmittance or solar control.

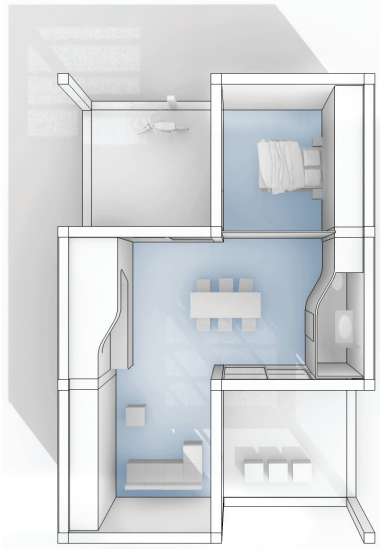
Type 3:
Special opaque façade elements combine passive and active solar energy use in a high-energy performance element. The translucent photovoltaic coating on the outside produces electrical power, the inner layers of special wooden slats and hemp insulation work in combination with solar radiation highly insulating and reduce heat losses to about half a conventionally insulated external wall with the same thickness.

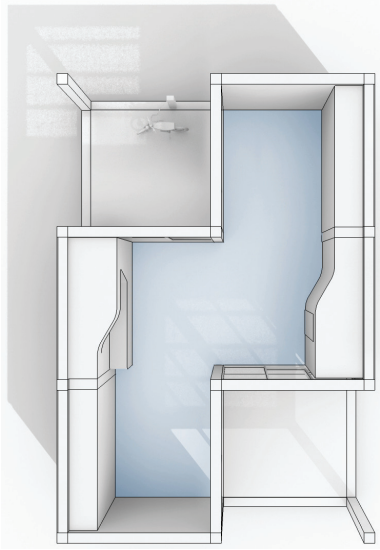
The Design for SDE 2012

The design for the SD Europe Competition 2012 is an exemplary solution of the ECOLAR concept based on the competition. The construction volume has 6 room units, of which 2 are formed as two-sides-open patios. They provide space for a carport with a solar filling station, a covered entrance and a terrace as private open space. In appropriate weather, the patios can also be connected to the interior over the slidable elements (type 1). The other 4 modules form the thermally conditioned area, which is optimized for 2 persons. The rooms are in principle open to every use and can be defined by using the specially designed, also modular super-cabinets. These include all use-dependant functions like furniture, storage areas, sanitary facilities and the kitchen which can be configured individually for each room module. This creates a flowing coherent volume, which allows a very generous sense of space. In view of the required usage the following 4 cabinet modules are realized:

- Module 1: The cabinet includes the furnishing of a bedroom with an integrated double-bed and storage space. Alternatively the room can be converted to a study with a cabinet-integrated desk.
- Module 2: Another cabinet-element includes all furniture and storage for a living space. Also included is a big, multifunctional Screen and a HiFi-audio system.

› Module 3: Built-in in this cabinet-module is the entire energy-system. Facing the room, a kitchen is also included. This can, if necessary, be moved into the room, so that a good accessibility of the technical equipment can be ensured.
› Module 4: The fourth cabinet-module includes a complete bathroom and space for a washing-machine and a clothes dryer.





The modules 1 and 2 form the individual rooms which are separated by sliding doors, which are also included in the cabinet system. Thus two separate rooms can be created if needed, for example for guests or to use the house as a three-room apartment community. The other two elements form a central common area that includes all important functions for this purpose: the entrance, the kitchen, dining area, a bathroom and the access to the patios. All modules have a direct connection to a fully glazed patio and therefore a very good connection to the exterior and daylight provision. The more private compartments will also receive diffuse daylight through the translucent front facades (Type 2). The Bathroom is supplied with daylight through a new daylight ceiling with a fiber optic system.

The artificial lighting concept is divided into two areas: The primary supply provide continuous light integrated in the gaps between the cabinet-modules and the ceiling, which produce a homogeneous illumination of the room. In addition there are a number of individual lights, which can be switched on depending on the usage scenario. The principle of the “light-gap” can also be found in the exterior of the building: the gap between the energy roof and the modules is also designed as a light-gap. Besides the interesting design effect, it also communicates the energetic functions of the building. It is lit when the power roof performs the function of thermal discharge of the storage tanks through radiative cooling. Once this process is not active or closed, the pulsating light gap is communicating the stand-by mode.

Integrated Building Technology

Another important aspect of the ECOLAR - concept is the integration of innovative high-performance technology, without compromising the residential character of the building itself. All surfaces – apart from the

glazing – are therefore made from local wood, and the entire building technology is fully integrated and invisible.

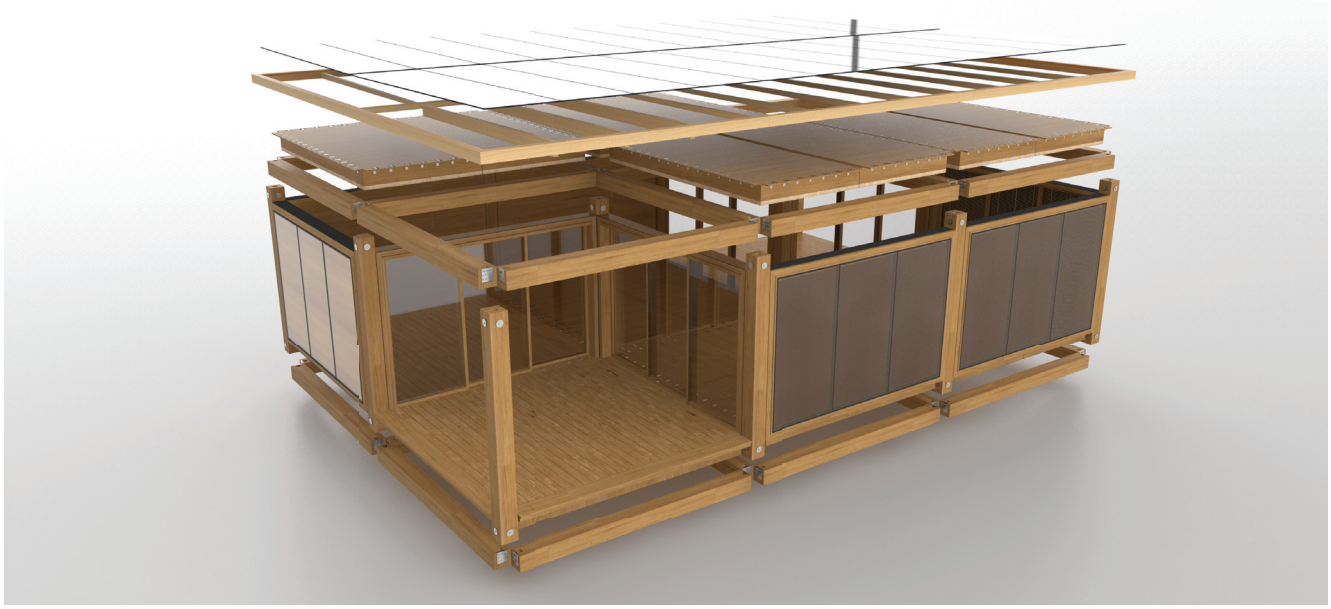
The following integrative and multifunctional approaches have been realized:

- The energy-roof is drained into an internal gutter, the downpipes are integrated into the inner columns of the structure.
- The interior floor elements have a built-in floor heating made from new graphite-coated wooden slats.
- The roof elements include a clay layer behind acoustically effective wood slats, which balances the humidity through the little gaps. Moreover, the clay-layer is mixed with PCM-material, thus achieving a high degree of thermal buffering of heat loads in the interior. Finally, the clay-layer is additionally permeated with water-carrying pipes, so that the ceiling can be used as an active cooling-element, if needed.
- Two ventilation appliances with heat recovery are integrated into the storage units and are easily accessible for maintenance.
- The air supply works via the light gab between the cabinet modules and the ceiling.
- For the air intake and the exhaust air the gaps between the opaque facades and the construction are activated. Between the “active” glazing and the construction elements, a corresponding grill is integrated.
- The gaps between the cabinet and the ceiling are activated by built-in LEDs for interior lighting.
- The service connections, water storage and building automation systems are included in the super-cabinet behind the kitchen, which can be opened towards the room.
- In the bathroom, the illuminated ceiling is fitted both with LEDs and daylight extraction elements. These are connected by wall-integrated fiber optics with the light receptor in the pool outdoors.
- Integrated in the outermost layer of the opaque walls are semi-transparent thin-film photovoltaics, which characterize the elevation of the house with its homogeneous translucent appearance.
- The water-bearing roof forms the completion of the cubic structure via a gap. It includes opaque and transparent photovoltaic cells on the whole surface. Additionally the rear side is equipped with solar-thermal absorber and serves, next to the water bearing, as an electricity and solar heat generator and night-cooling radiation device.

Engineering and Construction – Jury Report

Construction Design

The basic approach of the ECOLAR-Architecture is the potential expandability (or reduction ability) of the concept in all three dimensions: length, width and height. The ECOLAR architecture is based on a modular system with a 16m² cube as basis. After building the constructional grid out of columns and beams, various floor, roof and wall elements can be inserted into the supporting structure. Through this, the insulated hollow box sections and the surface elements form the energy-efficient thermal envelope of the building. Weather protecting cover panels on the outside of the supporting structure and a water-bearing energy-roof complete the building envelope.



The newly developed structural elements are made entirely from renewable resources. The columns and beams are hollow box girder made of wood. Thus they reach a much higher static efficiency compared to a solid wood construction with the same usage of material. Special glued wooden boards, made from split wood veneers without losses in the cutting process, are used for the construction. The cavities of the elements are filled with fast growing hemp fibers. Thus, construction and facades can be constructed in a common plane, which allows maximum flexibility. The elements are connected by simple single-supports made of steel and bolted joints. The entire construction of the structure and building envelope can be fitted and removed very quickly, with only three types of screws. The horizontal bracing in the longitudinal direction is set by the opaque façade modules, which are statically connected to the columns and beams. In the fronts of the ECOLAR-Home the transverse bracing was provided by a newly developed system made from static effective glass-wood composite. The statics of the developed support system in the current version allows a three- to four-storey structure, so that in addition to the pavilion, bungalow or atrium house also row-houses or multi-storey-buildings can be realized with the ECOLAR architectural concept.

Pipeline Concept

In the ECOLAR-concept water plays an important role. In addition to the rain water protection and the drinking water supply all thermal energy flows are realized through the medium of water or a water-antifreeze mixture. Through the medium of water in combination with highly efficient pumps and an intelligent control heat potential can be effectively transported. All pipes within the building are integrated into the wall, ceiling and floor panels; the fasteners are easily accessible. The rain-water from the energy-roof is drained into an internal gutter; the downpipes are integrated into the inner columns of the structure. It is collected in a storage tank underneath the building and used for watering the plants.

The drinking hot water supply is ensured through a storage in the technic room, which provides the kitchen and the bathroom with hot and cold water, either directly from the solar system at the roof, or over a heat pump. In the shower, the heat of the waste water is recollected through an integrated heat exchanger to the cold water supply. The active thermal conditioning of the interior works through the floor- and roof-integrated water pipes, which are fed through the utility room. This is connected both to the solar thermal system on the roof and the external water tanks, which serve as energy storage.

Electric Concept

Electricity is the main form of energy in the ECOLAR-concept. In Addition to the operation of household appliances, lighting and technology control, power for peak loads is also supplied by the reversible heat pump for heating and cooling. The aim of our concept is to create all power that is needed with the building envelope. Therefore three multifunctional photovoltaic systems are installed:

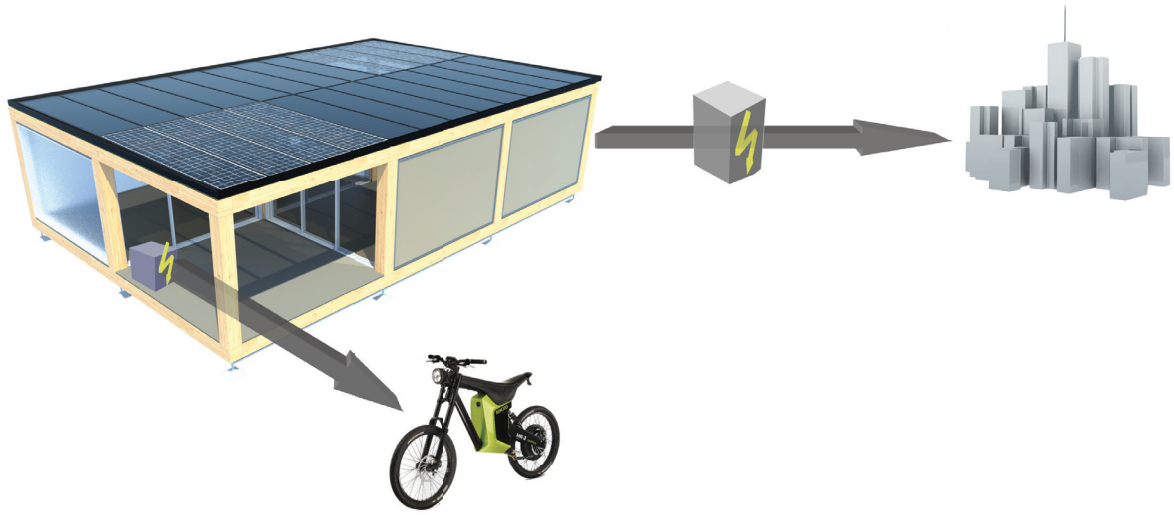
- Integrated into the outer layer of the opaque walls are built-in semitransparent photovoltaic elements that characterize the building with its homogeneous, translucent appearance of the view. The alignment to the east and west generates valuable solar power in the morning and evening hours. At the same time, the modules serve as a weather protection of the facade and create through the translucency passive solar gains.
- The water-bearing roof of the cubic structure contains above the interior room opaque photovoltaic modules, which are fitted in the rear layer with solar thermal absorbers. They assume in addition to the solar power generation the weather function tasks, solar heat gain and night radiation cooling.
- The water-bearing roof of the cubic structure contains above the patios transparent photovoltaic modules, which are fitted in the rear layer with a white transparent lamination. They assume in addition to the solar power generation the weather function tasks, daylight supply, sun protection and design the patio ceiling.

The gained solar power is used in the following priority:

- The solar power generated by the photovoltaic cells is used directly in the building if it is needed. The building automation system is optimized to bring the power demand and the solar range in coverage as much as possible (e.g. start of dishwasher and washing machine, heating of hot water tanks, cooling systems run-time).
- When additional electricity is produced, it will charge the solar-electric car through the solar filling station

integrated into the patio. During the competition, the solar-electric mobility will be demonstrated by an ECOLAR-scooter. In the reuse of the building after the competition it will be completed with an electric car.

› If there is more current surplus, it will be released into the public grid. The amount of surplus energy during the operating time of the building can be charged against the required energy for production from the life-cycle perspective.



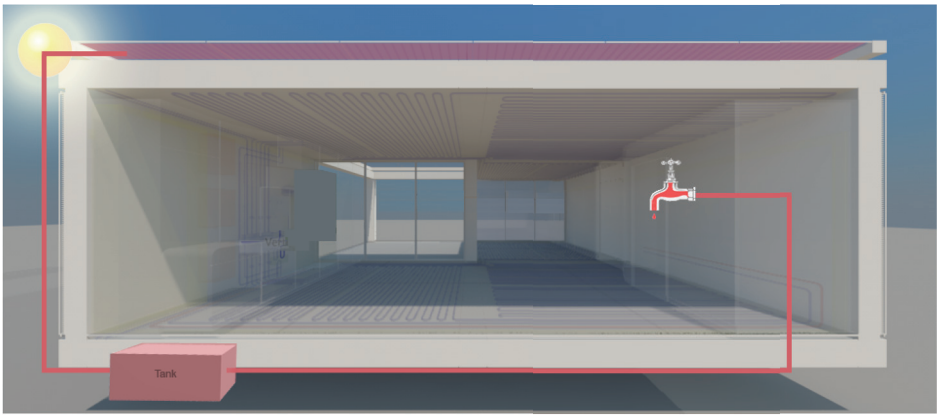
In the annual account the solar activation of the building envelope produces three times more energy as is required for its operation (located in middle-europe). Under the assumption that the system in the overall network will be completed by efficient storage options on a central level, the ECOLAR-concept forms a plus-energy building over the entire life-cycle, also including individual mobility.

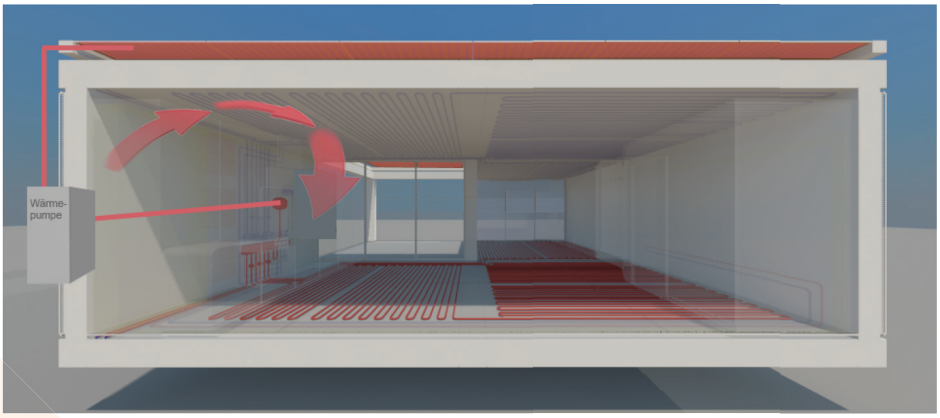
The Solar Thermal Concept

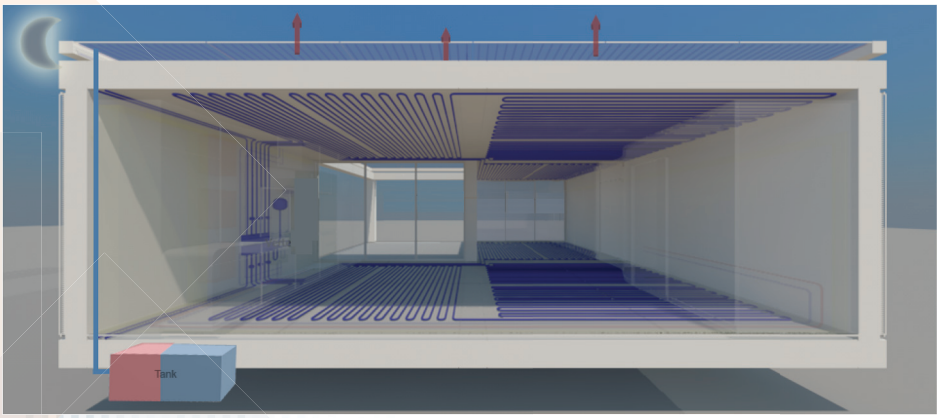
Next to the generation of electricity, the solar heat gain is an energetically valuable contribution. The thermal conversion is realized in three different ways in the ECOLAR-Concept:

› It is used to provide for direct hot water production like a traditional solar thermal system.
› At temperatures that are too low for direct use the heat potential is used as an energy source for the heat pump, thus replacing the usual air- or ground heat exchanger.
› In case of the cooling mode during summer, the solar thermal absorber is used to discharge the heat from the energy storage (loaded by the heat of the interior during the day) by radiation to the night sky.

Normally, photovoltaic and solar thermal systems are independently planned and implemented. With a high demand on the widest possible use of solar energy, a space conflict between the two systems occurs quickly. To use the existing roof area as effectively as possible, the ECOLAR-Concept therefore coupled the two systems. In the opaque area of the roof the water bearing photovoltaic modules are provided with a water-flow absorber plate on the rear side. This, in addition to the full-scale photovoltaic roof, forms a 40 m² solar thermal plant, which makes the waste heat from the solar power production available. The roof system is hydraulically connected both to the drinking water reservoir, the evaporator of the heat pump and with the external heat storage underneath the building. The reuse of the system after the competition will be extended with a ground absorber that is replenished by the solar system.







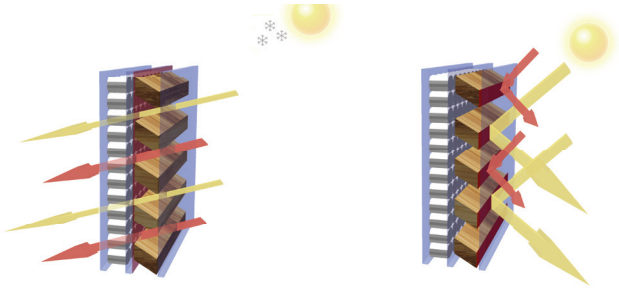
Energy Efficiency – Jury Report

Building Envelope

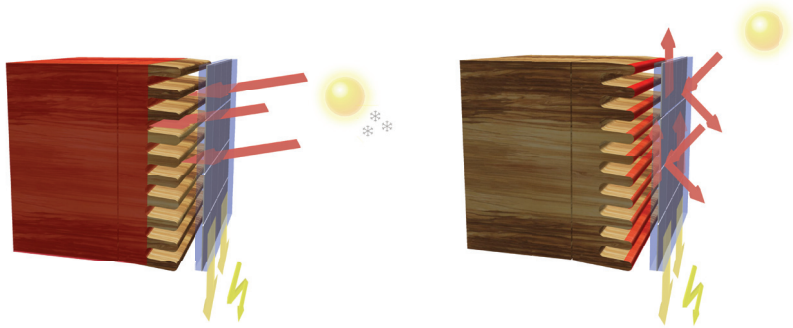
A good building envelope is the basis for every energy-efficient building. However, an unilateral optimization usually does not provide the best results. Use of materials and effects must be weighed against each other. The ECOLAR-concept ensues the following conditions:

- Only local wood from sustainable forests are used for structural parts.
- Only local, fast growing and purely biologically treated hemp fibers are used as insulation material.
- Only triple-glazing is used (future goal: vacuum glazing)
- The building envelope is to use solar gains in the heating period and to offer an effective external and individually adjustable sun protection in cooling periods.
- If possible, all unshaded surfaces are to be used for active solar energy use, which should be creatively integrated into the overall concept and always meet multiple uses.

Based on these conditions, a building envelope was created that provides an appropriate use of materials with maximum energy efficiency. The floor and roof elements, made from wood and hemp, have with a total thickness of 30cm very good U-values less than 0,15 W/m²K. The window elements with a Low-E-Coating and inert gas filling achieve U-values of 0,6 W/m²K. The newly developed translucent glass elements in the south and north facades are filled with horizontal wooden slats in the outer layer and with a special fleece in the inner layer. The wooden slats adopt the horizontal structure of the longitudinal walls. In the version for the south side they are slightly tilted and thus form an effective sunscreen. The fleece forms the sight protection and provides for a homogeneous and diffuse light. Both fillings act as a convection barrier and generate without noble gas also a Ug-value of 0,6 W/m²K.



The facade elements of the longitudinal sides form an energetic special. They consist of 4 different layers, which together provide a combination of passive and active solar energy use: The inner layer consists of hemp insulation, followed by a specially milled layer with horizontal wooden slats, which are slightly inclined downwards and after that an air gap. The conclusion and weather protection is a laminated glazing. This is coated with a transluzent photovoltaic layer made from amorphous silicium and actively generates electrical power. Through the 30-percent translucence, additional solar beams can pass through and warm the wooden slats and the spaces in between them. This then leads to higher temperatures than outside, which greatly reduces the heat losses by transmission. Precisely calculated openings at the top and bottom effect that during the heating season, an unmoved layer of air forms at a – relatively speaking - low temperature level in between the glass. During summer times at high temperatures these openings prevent a corresponding overheating of the façade element via convection. This creates a dynamic U-value, which has a value of less than 0,01 W/m²K (according to current measuring) during heating season. Thus the system is as efficient as a conventionally insulated exterior wall of double thickness.

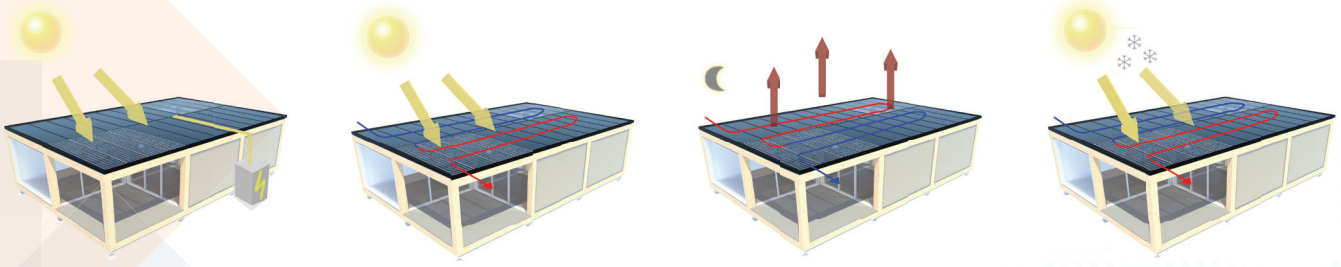


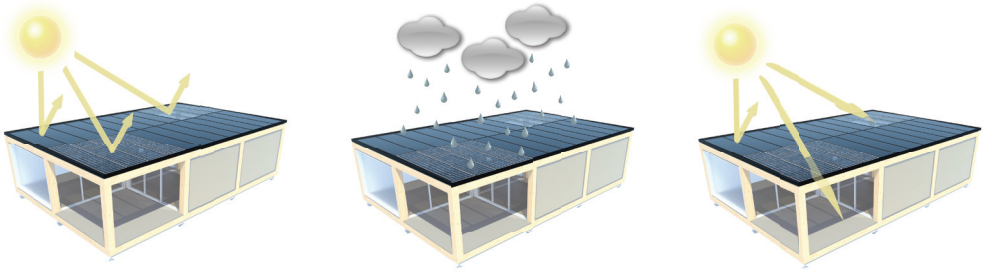
Solar Energy Supply

The energetic approach of the ECOLAR-concept is an efficient minimization of consumption and a widest possible use of solar radiation. All surfaces of the building envelope are using solar radiation either passive or active to generate heat, daylighting, power generation or cooling. The main components of the solar energy-supply-system are:

› The energy-roof made of hybrid elements from photovoltaic cells and solar-thermal absorbers.
› The opaque facade elements with passive heat recovery and photovoltaic cells
› External energy storage underneath the building
› Heat pump in the technic room
› Floor heating in the floor elements
› The water-flow-through clay boards in the roof elements

The solar power generated by the photovoltaic cells is used directly in the building if it is needed. The building automation system is optimized to bring the power demand and the solar range in coverage as much as possible (e.g. start of dishwasher and washing machine, heating of hot water tanks, cooling systems runtime). When additional electricity is produced, it will charge the solar-electric car through the solar gas station integrated into the patio. During the competition, the solar-electric mobility will be demonstrated by an ECOLAR-scooter. In the reuse of the building after the competition it will be completed with an electric car. If there is more current surplus, it will be released into the public grid. The amount of surplus energy during the operating time of the building can be charged against the required energy for production and maintenance from the life-cycle perspective. In the annual account the solar activation of the building envelope produces three times more energy as is required for its operation (located in middle-europe). Under the assumption that the system in the overall network will be completed by efficient storage options on a central level, the ECOLAR-concept forms a plus-energy building over the entire life-cycle, also including individual mobility.





The solar power used to supply the electric consumers such as household appliances, lighting and electric vehicles is additionally used as propulsion energy for the thermal management of the circulation pumps and heat pump. The premise of “passive before active” was realized as follows:

- The heat storage for water supply is heated primarily by the solar absorber of the hybrid roof. Is the heat amount or temperature level insufficient, the heat pump covers the remaining demand. This in turn uses the low temperature level of the solar system as the heat source and the solar energy as driving energy.
- The heating of the interior through the floor heating in basically the same method. A possible excess of heat during the heating season can be temporarily stored in the external energy tank.
- In the case of cooling, the interior heat will be conducted to the external storage, which is heated during the day, through the clay boards in the ceiling. During the night, the hybrid elements on the roof cool very quickly down to the outside temperature through radiation exchange with the clear sky. In this case the medium is circulated directly between the external storage and the hybrid element, whereby the latter is thermally discharged and is available again the next day. This passive cooling system is enough in Central Europe, according to the simulations, to create mild temperatures throughout the year with a COP of over 20. For higher requirements the heat pump can produce actively “coolness” by operating in reverse mode.

Ventilation Concept

The ECOLAR-Home has sliding doors in all directions, which are individually adjustable. Because of its location on the cross an effective cross-ventilation can be secured. In extreme times (colling /heating phase) two small ventilation units provide for the fresh air supply. These are integrated into the super-cabinet modules of the individual rooms and are provided with air through small grilles in the fassade-gaps. The exhaust air pipe works the same way, only offset. The air supply works through the light-gaps between the super-cabinet and the ceiling. The wasted air is sucked in in the utility- and bathroom. The ventilation units are equipped with a highly efficient heat exchanger. Thus, a permanent air quality is ensured with only low heat losses. Complementary heating or cooling coils are integrated into air supply ducts. Thereby, through splitting the devices, the rooms in the south and north of our building can be provided with different temperatures and individual air exchange rates, if this is needed.

Energy Balance

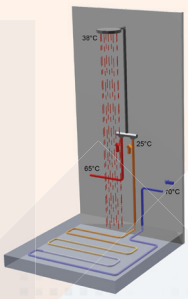
The ECOLAR-Home was accompanied by testing measurements and extensive simulations during the entire planning and implementation process. These mainly include:

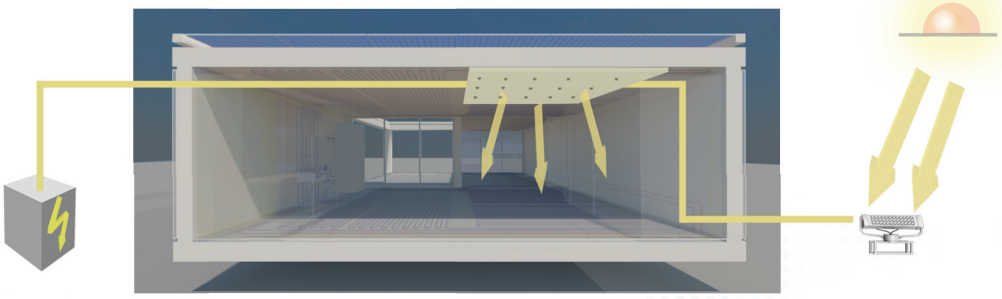
- The calculations of the energy characteristics of the individual components (U-values, g-values, t-values)
- The calculation of annual primary energy consumption for operating the building (heating, ventilation, cooling, lighting)
- The calculation of the maximum heating and cooling loads (design)
- The dynamic calculation of solar gains and cooling phases (load management)
- The simulation of the heat pump in conjunction with the energy store (dimensioning)
- The simulation and test measurements of the solar hybrid roof elements (performance)
- The simulation and test measurements of the opaque active/passive solar façade (dynamic U-value)
- The simulation of underfloor heating (performance)
- The simulation of the climate-ceiling (performance)
- The natural and artificial lighting simulation (parameters)
- Calculation of primary energy demand for manufacturing (LCA)

The learned knowledge were integrated into the planning process and led to the realized outcome. An important element was and is, in this context, to maintain the transparency of the energy flows out through the planning process to the operation of the building. Therefore a communication interface was programmed, which informs the user via a touch screen and the internet about all the essential building functions and energy parameters. This interface allows the residents to directly and intuitively take part in the home automation and control.

Technic Components

Regarding the equipment of energetically significant components, a high priority was laid on efficiency:
- All home appliances conform the highest efficiency standards
- The electric lighting is exclusively with highly efficient LED systems
- The heat pump was developed specifically for the building and works in spite of the small power with two compressors to ensure an optimal part-load performance
- The external energy storage consists of three tanks which are connected as a cascade. So despite a low height, the maximum temperature level can be stored.
- The shower is equipped with an integrated heat exchanger that recovers heat from the waste water.
- A charging station for electric vehicles in the entrance patio is an integral part of the building
- The bathroom is supplied by a daylight control system. Outdoors a daylight collector bundles and directs solar radiation into optical fibers. In addition to the LEDs the corresponding light-outcoupling-elemets are integrated into the bathroom ceiling.



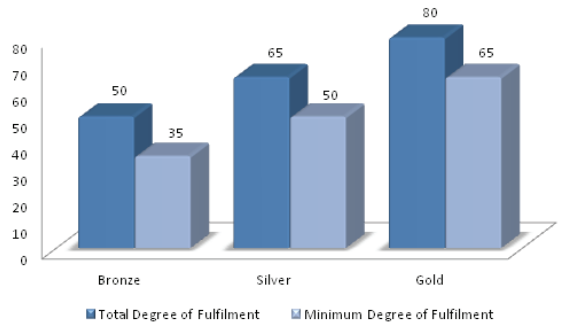


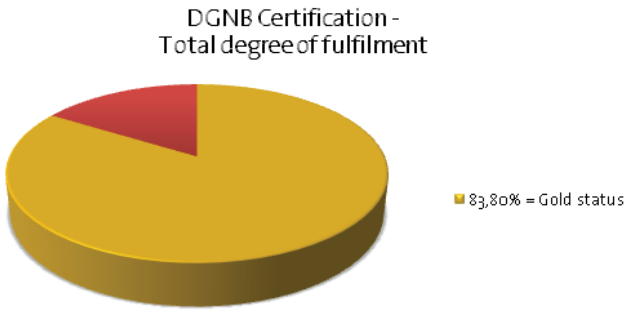
Sustainability – Jury Report

Certification

The sustainability of the ECOLAR Home is one of the most important aspects of the concept. For this reason, Team ECOLAR decided at an early stage of planning to get certificated by the DGNB certificate, one of the most demanding certification systems of the world. The goal is, to reach the gold standard of the DGNB criteria for small residential homes 2012, in whose pilot phase the ECOLAR Home is taking part. After the Europe Solar Decathlon 2012 the house will finally be certificated. The whole bandwidth of characteristics of the building and its location, as well as the necessary processes are considered and divided into six categories.

As a result of the pre-certification, you can see in the diagrams that the ECOLAR Home will pass the hardest test of sustainability with 83,80%, what means even a gold certification. For the gold status, the house needs to be rated with at least 80% as a total degree of fulfilment. In each category need to be achieved at least 65%. The Ecological quality of the ECOLAR Home is estimated with 85,80%, the Economical quality with 67,40%, the Sociocultural and Functional qualities with 90,10%, the Technical quality with 89,00%, the Process quality with 90,50% and the Site quality with 90,30%.





Sustainability Concept Applied

The ecological, economic, socio-cultural and process qualities were put forward during the development of the ECOLAR concept. The use of renewable energies and ecologically high-quality materials is an important principle. In this case, however, not only the raw material is considered, but also the method by which it is recovered and processed. Therefore, we rely on natural materials with a minimum of primary energy demand as well as a low environmental impact and that are made without the use of toxic substances.

A high economic quality can be assured by cost efficient series production of the construction components. Even better, you can buy second-hand ECOLAR parts through a specific exchange market. The building will not only be affordable regarding initial costs, but also remain affordable regarding operation costs. Through a passive house technology concept with low energy consumption, low maintenance effort and the possibility of interchanging damaged parts, the building can be kept intact without much additional investment. Even conversions in functional terms, or adjustments to the state of the art are possible.

The principle of „Change your life - Change your house“ stands for the socio-cultural qualities of the ECOLAR concept. It allows the customers to actively participate in planning their individual home and of course in the realization. Thus they not only have great influence on the design, also the attachment to their house will be strengthened. In addition, it is possible for them to expand or convert the house at any time, so they don’t need to specify one fix room configuration.

The super cabinet optimizes the efficient use of space in the interior. The high quality materials will offer a comfortable interior ambiance and a pleasant climate. They also provide visual and acoustic comfort. At the end of the buildings life cycle, it can be easily dismantled and recycled. Good planning of the construction site, a sound risk management and professional partner assist the process quality.

Bioclimatic Strategies – Passive Design Strategies

The northern and southern facades of the ECOLAR Home consist of a new triple glazing system, which permits diffuse light into the room and creates bright, naturally lit interiors. The innermost interspace is filled with a special capillary inlay that distributes the sunlight evenly.

The eastern and western facades are built with an innovative product, which uses specially designed wooden fins that reflect most of the sunrays during summer months to keep the house cool and absorb solar heat in the wintertime to create an insulating air cushion. In front of the wooden fins is a layer of photovoltaic cells that generates solar power.

The roof is the power station of the ECOLAR Home and contributes to the passive heating and cooling system. After a sunny day, the roof cools passively down during night-time by radiation exchange with the sky. An absorber conducts this coolness into the storage tank underneath the building from where it can deliver the interior if needed. In addition, the roof serves as a solar thermal system to heat up the potable water. Pipes in the ceiling transport the solar heat that is produced on the roof into storage underneath the building.

Beside heating and cooling through the solar roof, the PCM (Phase Chang Material) supports passively the thermodynamic totalsystem. During daytime, the PCM absorbs the warmth, which is produced in the interior and stores it. If the outside and consequently also the interior temperature begin to fall, the PCM gives its energy to the room. So the ceiling is able to absorb heat without consuming energy. The clay in the ceiling acts as a passive humidity manager.
The glazing elements around the two patios guarantee a natural cross-ventilation.

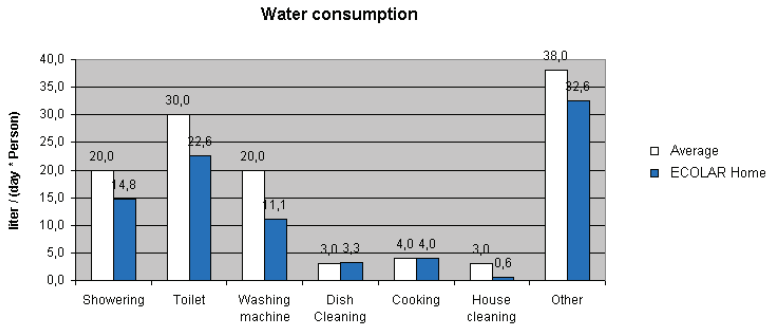
Water – Reduction of Consumption, Recycling

Compared to an average household, the water consumption of the ECOLAR Home is obviously lower. The ECOLAR inhabitant needs only 89 litres water per day. This is 42% less than the German average consumer, who needs 126 litres water per day.

For choosing the household appliances, special care was taken to the low energy demand and water consumption. (See diagram)

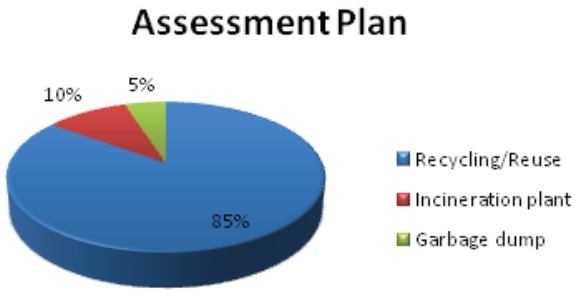
The ECOLAR Home has got a rainwater tank located under the deck. The rainwater is purified through a special filter system and is used for irrigation purposes and to water the basin. Once the house arrived at its final location in Constance, it is also planned to develop the system further so that the rainwater can be used for the shower or the clothes washer. Additionally, then the grey water will be collected and purified,

too. It will be gained from the used water of the shower and the washing machine and will be used to flush the toilet, for example.



Solid Waste – Assessment Plan, Maintenance Plan

Because of the modular and flexible system of the ECOLAR Home, all the components are easily removable. The sustainable and ecological concept guarantees that most of the materials are recyclable, for example the whole wooden construction. The single components of all the facade, floor and ceiling elements are easily to dismantle and to separate from each other. In this way, a simple replacement of broken or used elements is possible and the life cycle of the building is extended.



Materials Selection and Incorporated Energy

One aspect of sustainability is a long duration of the used products. In general, the selection of materials for the ECOLAR Home was carried out using the self-developed requirement specifications. The materials are therefore very sustainable, they are easy to recycle, low-polluting and contain no toxic substances.

The most important material in the ECOLAR Home is wood. The whole construction, the ceilings, the floors, the super cabinet, the outer deck and the window frames - everything is made out of this renewable material. To guarantee a harmless recycling, no chemical wood preservers are used. The origin of all the wood is proved and FSC or PEFC certificated.
To insulate the building, ecological hemp insulation is used. It is also a renewable, recyclable, low-polluting material that doesn't contain any toxic substances and hemp grows in the period of one year. The utilization

of clay boards in the ceiling is a natural way to regulate the interior humidity and improve the sound quality.

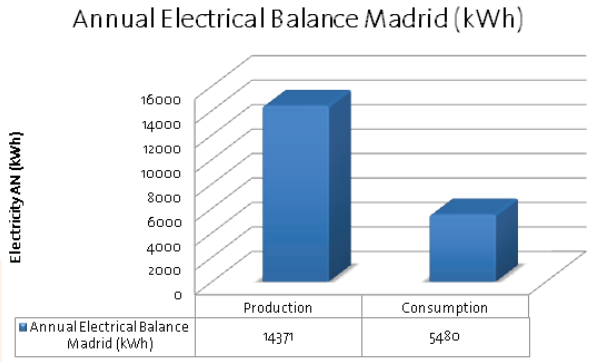
The ECOLAR Home is a solar plus energy house. Not only because of the rules of the Solar Decathlon competition, but also due to our personal commitment, the ECOLAR Home produces more energy than needed for its own operations. But only if the house produced more energy than was used for the manufacture and construction as well as for demolition and recycling later, it can be described as truly sustainable.

To follow and evidence these properties, the eco-balance was calculated: The not renewable primary energy demand PEnr is 21,41 kWh/m²NGF*a and the total primary energy demand PEtot is 77,74 kWh/m²NGF*a, which is much lower compared to an average house´s with about 110 kWh/m²NGF*a. (The renewable primary energy demand is 56,33 kWh/m²NGF*a).

The essential global warming potential (GWP) of the ECOLAR Home (building manufactoring and maintenance) is 7,45 kg/m²NGF*a, the total amount (64 m²NGF and 50 Years) is 23,48 t of CO_2 emissions.

Solar Facilities – Energy Data

The entire roof of the ECOLAR Home is covered with two different types of photovoltaic modules: Black design cells on the roof and translucent cells above the patios. In addition parts of the facade are solar activated. As a total, even more energy is produced than consumed - the ECOLAR Home is an energy plus house. The total profit amounts to 14371 kWh per year; the consumption is 5480 kWh per year.
Referring to the total amount of surplus energy, 5,3 t of CO_2 emissions are saved every year.



Assuming, that the system in the overall network will be perfectly managed or completed by efficient storage options and the whole surplus energy will be used, the ECOLAR home is able to pay back the incorporated energy after 5 years of usage.

Industrialization and Market Viability – Jury Report

Our idea is to plan, produce and distribute a modular, energy efficient and expandable house. ECOLAR supports a sustainable building method by using a modular design principle which is path-breaking for a sustainable ecological and carbon neutral society.
By using prefabricated, standardized elements, it is possible to guarantee a competitive and simple reproducibility of the modules. These modules can be combined in any order- horizontal and vertical - to design individual living space. Additionally the sophisticated architectural design emphasizes the exclusiveness of the houses.
This enables our customers to compose any house he likes, matching his personal desires and needs. And if they change, the building adapts easily. Design, equipment and comfort illustrate the house of the future. The inhabitant won´t have to look after the implemented technologies - the technology is looking after the inhabitant.
An increasingly tensed situation on the residential market, especially in the metropolitan areas, suggests a more and more dynamic selling market, in particular for prefabricated houses. Due to the high flexibility, the very short assembly time and the low price we can achieve by prefabrication of all the houses components, we will revolutionize the residential market with this design concept.

Our Vision

ECOLAR is a company based in Germany which is internationally developable, primary in the market of residential and construction industry. It forms an own label as its business identity, which creates a strong empathy that is linked with the picture of an ecological and sustainable society. So ECOLAR is always linked with environmentally friendly buildings and living space. This image is important to convince new customers.
The business mission consists of providing sustainable, energy efficient living space for everybody and to shorten long construction times for our customers. For us, an ecological compatible and reasonable orientation of our products is a basic necessity because of ecological and social factors. Initially, the range of products covers exclusive, upscale living spaces as well as office spaces, industrial real estates and multi-story residential buildings. To complete the range of products we extend the modules to carports, exhibition- or showrooms, pavilions and similar products.
As a long-term goal, we want to make the ECOLAR Home financially accessible to the mass market. Achieving this, the ECOLAR Home will play an important role in supplying living space and energy in future. But the product doesn´t only offer chances for European or developed countries. A high potential can be seen in markets of developing countries like Africa, the Middle and the Far East. It is important to offer self-sufficient living space for these countries, which can be assembled in a short time. It is also clear that those buildings do not offer the high-end interior known as western standard. But with the modularity and flexibility of the ECOLAR Home it is possible to realize a cheap and basic self-sufficient house to give a chance to people living in bad circumstances today.

Additionally, the company offers not only the product itself, but also the maintenance and upkeep of the house. This can also be optimized through leasing contracts, which ensure that the technology is constantly kept up to date. Thus it is also ensured that the competitive advantage is warranted sustainably. This package also offers the possibility to individually design a house which is not expensive to manufacture, holds the highest degree of flexibility on the cutting edge of technology, focusing aesthetically and comfortably the highest level. Once the ECOLAR Home is established, also the larger projects such as townhouses or multi-family-buildings are planned. A step further in the future could be an uncoupling of a new product line with ECOLAR carports, which then can be purchased separately or as add-on products to directly load electric cars with the houses power.

The advantage of our system is that the basic concept can always be used. The structural elements themselves don´t have to be changed. With the individual components, all residential structures can be erected and rearranged as needed.

The biggest advantages of the ECOLAR home are:
› short assembly time because of a high degree of prefabrication and a simple unit construction system
› individual combination of interior and exterior equipment
› extension or reduction of the ECOLAR Home at every time
› low costs as a result of leasing models and lowest running costs by being self-sufficient
› the house can adapt to the inhabitants needs, and even can move with them

Target customers

Unit Production

According to the SINUS-Milieu-Study and with the results of an own survey with about 150 questioned persons of all ages it is possible to identify diverse important target customers for the different stages of the company. The focus during the initial period of the company - while 1-2 houses/year are produced and sold - is on those customers located in the liberal intellectual milieu. We call these customers the “High Society” and for them the ecolar home is a sustainable object of prestige with a convincing architectural design. These customers of category Sinus B1 are marked by ethics of success, feasibility-thinking and distinct standards of excellence. They are between 40 and 60 years old and they live in 3- and multi-family households. This fundamentally liberal, enlightened educational elite with post-material roots, a desire for self-determination.

Serial Production

If we can raise the production level up to 100 houses/year, three more target groups will enter our sales market. We are able to obtain the categories Sinus A12, Sinus B12 and Sinus C12 with more favorable prices. This “Upper Class” consists of the established conservative milieu (A12), the high achiever milieu (B12) and the movers and shakers milieu (C12). The established conservative milieu represents the old German well-educated class. They are marked by conservative cultural critique, humanistic conscientiousness and cultivated behavior. They are older than 60 years and live in 2-person-households. Among these people academic degrees are overrepresented and they derive middle or upscaled incomes. The high achiever milieu can be named as enlighte-

ned post-68-milieu. They are marked by a liberal tenor, pursue post-material values and they are intellectual interested. They are between 20 and 60 years old with a high level of IT and multi-media expertise and live in major households with children. They are high or highly educated and derive high incomes. Finally, the movers and shakers milieu are the unconventional creative avant-garde. They are hyper-individualistic, mentally and geographically mobile, digitally networked and always on the lookout for new challenges and change. They are younger than 30 years, have got a high educational level and got a high household income.

Large-scale Production

Has the ecolar home established itself on the market, and up to 1,000 houses per year can be produced and sold, a quick supply of sustainable-energy houses or apartment buildings can be ensured. The target customers for this scenario can be found in the Sinus B2 category, the new middle class milieu or simply “middle class”. This layer embodies the modern mainstream with the will to achieve and adapt. The people belonging to that class strive to become established at a professional and social level and seek to lead a secure and harmonious existence. They are between 30 and 50 years old and mostly live in multi-person households with children. They have qualified educational degrees and they derive middle incomes.
Beside this mainly private target customers the public construction sector is interesting, too. The German municipalities must offer about 230,000 places in kindergartens until 2015 that don't exist yet. The fast unit construction system of ECOLAR offers an attractive alternative to conventional massive buildings.
Based on a SWOT analysis the Strengths, Weaknesses, Opportunities and Threats for the project were analyzed:

S	*W*
• *adaptable (flexible, modular)*	• *high initial investment*
• *expandable*	*reducible by leasing*
• *sustainable image*	• *long recovery time*
• *low running costs*	• *potentially restricted building height*
• *cost certainty*	• *adjustment for solar radiation*
• *price guarantee*	• *favor of modern architecture*
• *translocateable*	

O	*T*
• *wide range of products*	• *building regulations*
• *Lean Construction*	• *reduction of aid money*
• *technical upgrade (leasing)*	• *competitors*
• *international distribution*	

Supply of Services:

In order to generate added value for the customer and to achieve a better position in the market, we offer more services than planning and developing an ecolar Home:
“Ready to move-in” production - We offer our customers to care for the entire process of building. We organize the complete construction in the sense of a general contractor, which means we work together with external firms on site, which accomplishes and supervises the construction of the prefabricated elements by a well-established team of experienced craftsmen. Thereby not only the costs are kept low, but rather to ensure fixed price and high quality. The client enjoys the comfort of moving to a house ready for occupancy without having the stress to build it.

Another option will be customer consulting and customer support or service and maintenance throughout service life. In particular we will offer an optional maintenance contract. This includes a quality upgrade with an included warranty extension beyond the statutory 5 years. At the regularly performed maintenance, new products and services will be presented to the customer. Thereby the costumer contact can be held permanently. The house is always on the cutting edge of technology without the need of the owner to take care himself.

Prices

The ecolar Home will be represented in the high-price segment at the beginning of the product life cycle, particularly in regional markets, such as Hamburg, Berlin or Stuttgart with a growing population of young, professionally successful and financially powerful people. The modular design significantly reduces the costs here which permits us better profit margins. By collaborating with experienced and reputable firms of prefabrication and the realization of the house with the so-derived know-how in an early planning stage, low manufacturing costs and high quality design at an affordable price can be guaranteed.

	Low production level 1-2 houses/year	*Medium production level 100 houses/year*	*High production level 1000 houses/year*
Production costs per house	*€ 500,000*	*€ 350,000*	*€ 200,000*
*Recovery time**	*4 – 5 years*	*1 year*	*2 months*
Benefits per house	*€200,000*	*€150,000*	*€100,000*

**It is assumed that the initial investment amounts €1.5 million.*

However a very important issue to communicate in conjunction with the ECOLAR-concept is not only to focus on the capital cost. In consideration of the energy production while using the home the essential values are also the annual charges.

Comparison of an average residential building and ECOLAR Home

	Average residential building	*ECOLAR Home*
Inhabitants	*4 Persons*	*4 Persons*
Construction costs		
Living space	*120 sqm*	*120 sqm*
Investment costs per sqm	*1,600 €/sqm*	*2,084 €/sqm*
Total investment costs	*192.000,00 €*	*250.000,00 €*
Energy demand		
Energy demand – heating & warm water	*8,000 kWh/year*	*3,200 kWh/year*
Energy demand - electricity	*4,000 kWh/year*	*4,500 kWh/year*
Total energy demand (heating & electricity)	*12,000 kWh/year*	*7,700 kWh/year*
Energy demand per sqm	*100 kWh/sqm year*	*64 kWh/sqm year*
Energy costs		
Energy costs – heating & warm water	*0.065 €/kWh*	-
Energy costs – electricity	*0.18 €/kWh*	-
Total energy costs	*0.065 x 8,000 + 0.20 x 4,000 = 1,320 €/year*	-
Energy production		
Energy production per sqm	-	*100 kWh/sqm year*
Total energy production	-	*12,000 kWh/year*
Own energy consumption	-	*7,700 kWh/year*
Earnings for own consumption	-	*0.16 x 7,700 = 1,232 €/year*
Feeding into the grid	-	*4,300 kWh/year*
Earnings for feeding into the grid	-	*0.24 x 4,300 = 1,032 €/year*
Total earnings	*- 1,320 €/year*	*+ 2,264 €/year*

Communication and Social Awareness – Jury Report

Preparedness

The communication plan is an important part of ECOLAR project. Because it includes everything that has ever gone and will go public about the project. All information about actions and events of the team, as well as all references in newspapers, on websites, on television or radio. In addition, we collect all analyses and ideas we created in relation to our communication work and keep records about developments in the external appearance (Corporate Identity). Apart from all the past actions, the communication plan also grants a glimpse into the future of our project. Therefore it is not only an important and useful reference but also an essential planning tool that is constantly being optimized. In an afford to do a professional job the responsible team members were trained by experts in special workshops like „Development of a creative guide for Team ECOLAR“ or „Journalistic writing and photography“. We want to continue to organize workshops of this kind after the competition, for further improvements of communication and public relation skills of the team.

The Communications Objectives

A main goal of the Solar Decathlon Europe is to inform the public about the latest renewable energy sources and their application and to raise public awareness of environmental protection. This goal is exactly what Team ECOLAR also strives for! We seek to show how easy it is to live greener, and that this change does not mean a loss of comfort or high expenses. The ECOLAR Home is the best example for that: It uses only the power of the sun to provide for the daily energy consumption of its inhabitants. Nevertheless, it has everything your heart desires, including an attractive design and a highly modern technical equipment. The high degree of prefabrication allows an easy assembly and disassembly and the serial production process reduces the costs of the components, which makes the house affordable for everyone. Therefore we already try to reach and involve as many people as possible during the development of our project. To achieve this, we apply various methods and use different types of media.

- Public performances (Local festivals, exhibitions, public lectures, surveys, parties,...)
- Own website (updatet information, announcements and promotions on the homepage, facebook or via twitter)
- Media coverage (newspaper articles, interviews, newsletters and reports in television and radio)

Target groups and activities

The target groups we have defined so far are divided into the following groups. Depending on education level and previous knowledge they have different needs and expectations:

- Children
- Youth (Pupils)
- Young Adults (Students)
- University Staff (HTWG)
- General Public
- Press (general)
- Technical Press

- Radio
- University Television
- Professional Television
- Sponsors

On this note we enforced more than 60 communication activities in a great variety of impact like

- Exhibition on trade fair, e.g. BAU Trade Fair in Munich or BauhausSOLAR Trade Fair in Erfurt
- Oral presentation at expert conference, e.g. Clean Energy & Passivehouse – Symposium in Stuttgart or Energy Days Berlin
- newspaper article, e.g. Südkurier (Souther Germany)
- Article in professional journals, e.g. Ingenieurblatt
- Using digital media, e.g. homepage, Twitter or facebook

Further outstanding measures are the following:

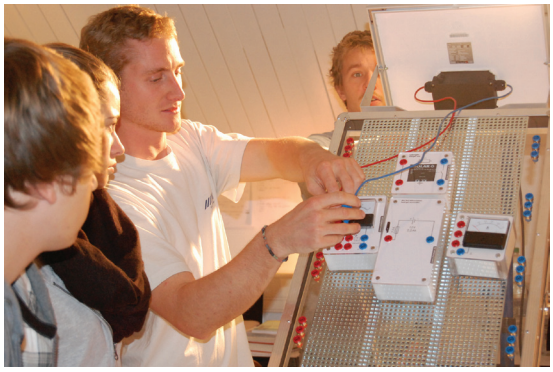
- Interview in public radio SWR: An interview with Professor Stark on the SD Europe in general and our project in particular)

- Public event in Constance „Ausgesprochen Wissenschaft“: Interview with our Professor in the „Vogelhaus Café“ on renewable and solar energy in general and our house in particular.

- “Ministry Visit”: Minister for Research, Science and Art, Theresia Bauer visited the HTWG and our team. We present our project on campus in the true scale model while the university-TV is present

› Sports event “Old Town Run Constance”: The ecolarians run along – the award ceremony was held in our 1:1 construction model

› “Photovoltaic Actionday”: A school class visited us to learn more about renewable energy and our project



› “Adventscalendar Action”: all Facebookfriends take part at the raffle with sponsored gifts. The contributions came from different Shops, Bars and Restaurants located in Constance

› Start of „ECOLAR around the world“ action: Communicate the ECOLAR-philosophy around the world and take a picture of the mobile ECOLAR-CUBE

› „Ministry Visit“: Minister for the Bundesrat, Europe and International Affairs, Friedrich visited our construction site

› „Week of the environment Berlin“ Exhibition by invitation of the Federal President of Germany