levelup

levelup your ...

Sustainability

Jury Brief Report #3

solar decathlon 21-22 europe
WUPPERTAL GERMANY ...goes urban!

Technische Hochschule Rosenheim

1. Circularity

1.1 Materials and construction

In selecting materials and components for the „levelup“ system, the focus was on renewable, bio-based raw materials or secondary raw materials, and the principle of „design for disassembly“. All of our built objects making up the construction are planned and designed so that they can be disassembled at the end of their life cycle, by separating each material to its maximum. Our building consists of a very large proportion of wood from sustainable forestry and is nearly 100 % recyclable. This minimises the negative impact on the environment, climate, and quality of life even after the life cycle. The wood used in the project is, if possible, untreated or if necessary, treated with bio-based, VOC, and pollutant-free oils.
After disassembly, all timber should belong to waste-wood class 2, which improves its cascading use before the end of its life. The CO2 stored in the material can remain in the building element long-term and serves as a greenhouse-gas sink. The use of wood in two different cascading functions can be demonstrated with our solid wood walls and our furniture made of sustainable chipboard. The solid wood walls with diagonal spruce sheathing are mechanically nailed, without glue, using Lignoloc® wood nails - a development of the TH Rosenheim and the Raimund Beck KG. Upon disassembly, they can be separated more quickly than common metal nails, or they can be processed as a single material, with minimal effort for the next cascade stage. We use sustainable chipboard „Beyond“ from Swiss Krono AG for our furniture. It consists of 100 % recycled wood and bio-based adhesives. Unlike solid wood furniture, our furniture is ecological, affordable, and realistic for subsidised housing.

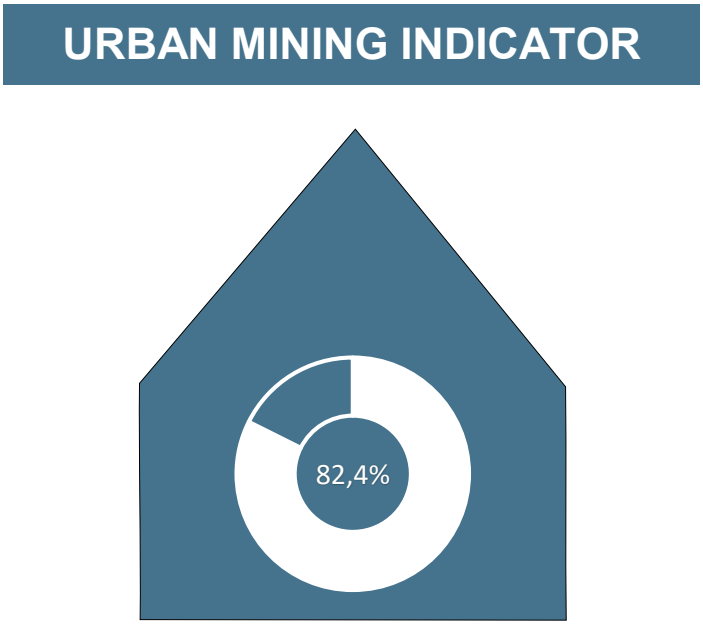

Figure 1 - Beschreibung - Dem egit; non sum conloca strionsus, Ti. Nostioribem ni publis nonsupi caedem molude atus

1.2 Maintenance

During the construction of the HDU, great importance is being attached to ensuring that the pipes - electricity, water, and air - are permanently accessible and allow for damage-free maintenance and replacement. We require this principle because we are developing „levelup“ as a modular, fully prefabricated, „plug & play“ system. All cables must be connected to the module and element joints in a convenient and accessible manner. The wires are located either behind the removable wall panels, ceiling panels, floor covering or in freely accessible ducts. The entire electrical wiring runs, e.g. in the skirting board. The cabling can be easily retrofitted or replaced at any time. Switches are radio-controlled, so no wiring is required in the walls. This means that the HDU has no sub-surface electrical wiring for the switches or pushbuttons, as they are operated by wireless.

The earthen building panels can be attached directly to the solid wood wall, which gives us a very high thermal mass despite the lightweight construction and is very advantageous for thermal insulation in summer. Our bathroom is an absolute special feature because all wall and floor coverings are mechanically attached and quickly removable. This means that the cladding itself can be replaced without damage, but all the pipes are freely accessible and can be replaced with a minimum of time and expense.

1.3 Circular economy concept

We use renewable wood and recycled materials for construction. Examples include recycled steel on the pergola, kitchen countertops made from recycled glass, and wall and floor cladding in the bathroom made from recycled rice waste. Our silicone-free bathroom in the HDU is an absolute novelty. Here, levelup has developed a bathroom without the use of any joint sealants, because wall and floor covering consisting of waterproof, UPB Resysta® panels are to be used. All wall and floor elements can be removed and replaced easily, which enables damage-free and quick maintenance of the subsurface utilities. This also circumvents the need to demolish and reinstall permanently installed wall and floor coverings, e.g., ceramic or stone tiles. The water-resistant Resysta® panels negate the need for waterproofing or standard bathroom wall and flooring treatment. Depending on the panel type, Resysta® panels can be 100 % recycled at the end of their life cycle. Resysta® panels are made of over 60 % rice husks, an agricultural waste byproduct that would have been otherwise used thermally or disposed.

In all other rooms, Claytec® wallboards will be used to plank our solid wood walls, as no subsurface utility ducts or channels are required. We have chosen to use the Claytec® (clay wallboards) with a jute reinforcing fabric, instead of the standard glass fibre. No painting will be needed because the wallboards will be plastered with pigmented clay plaster. Furthermore, the panels can be 100 % recycled at the end of their life cycle, i.e. shredded and used again as clay building boards in a closed process or completely composted. They are made of natural and regional raw materials that contribute significantly to a healthy and comfortable living environment while protecting the wooden construction from moisture and fire.

The arcade on the HDU is made of 100 % recycled steel. The external exoskeleton structure on our main „Design Challenge“ building, consisting of escape stairs, lifts, arcades, and balconies, cannot be made of wood due to static, fire resistance and safety restrictions. In order to compensate for this, our steel structures, including the HDU, will be made from „XCarbTM“ from ArcelorMittal Europe. Their steel is made from 100 % recycled steel and is produced using 100 % renewable energy. Galvanising the steel permanently protects it and allows for an optimal „closed-loop“ recycling according to the Cradle to Cradle® principle. This principle also pertains to our HDU and our Design Challenge building, because the steel can be sorted by type and fully recycled in a closed loop without any loss of quality.

Sustainability is also a priority in energy and building technology: for example, we use an environmentally friendly propane heat pump from Ecoforest® that can be installed indoors. Natural refrigerant propane has a significantly lower greenhouse gas potential than conventional refrigerants. Production and end-of-life disposal are straightforward.

After the competition, the HDU will be set up and operated permanently as a day-care centre and family office on our campus in Rosenheim. For this reason, we have taken repeated assembly and disassembly phases into consideration, long-term use, easy maintenance, and 100 % component-separated dismantling. All component assemblies are screwed, or nailed with wooden nails, making it easy to replace individual layers, dismantle them, and recycle them to nearly one hundred percent.

2. Sufficiency, Flexibility & Environmental Performance

2.1 Biodiversity

Our addition of storeys “stacking” system means a reduction in new construction or development of undeveloped land. Our additional green areas and surfaces on the roof, create new green spaces and counteract additional urban expansion. By adding storeys to existing buildings, we protect the soil and water cycle as well as living organisms in the soil. Through intensive greening, we strengthen biodiversity, and the multiplication of our system can transform entire neighbourhoods into new habitats for living creators. Additionally, plant life contributes to climate neutrality and to the cooling of urban environments.

The steel exoskeleton provides optimal support for climbing plants on the side of the Design Challenge building facing the lawn between the buildings. An extensive bee pasture could be planted along the entire length of the building on this facade, which would also allow for bird-nesting sites. The roof landscape offers space for various types of greenery, where we have emphasised water retention, evaporative cooling, and coexisting biodiversity. Intensive greening is planned for all accessible roof terraces, where shrubs and small trees will provide shade in summer and flowering perennials will attract insects. These areas are intended as recreational oases and retreats for all residents. We have also planned areas for urban farming, e.g., growing herbs and vegetables, which would allow residents to supplement their own food supply, save money, and gain satisfaction. These undertakings result in green communal areas with a connection to nature all year round, which further promote pleasant and healthy indoor and outdoor climates to rest and communicate away from busy streets.

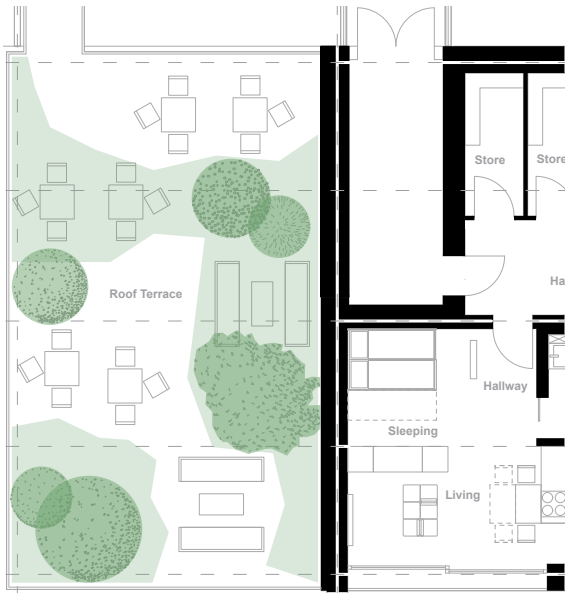

Figure 2 - Level 2 of the addition of storeys with a roof terrace

2.2 Society

The „levelup" system offers two different flat sizes. Four modules each form a flat with 78 m2 for 3 to 4 people and the two-room flat consists of two modules each with 36.5 m2 for one to two people. With approximately 21 m2 of living space per person, our design is less than half the current average

Figure 3 – Group of resident of the Design Challenge

Open floor plans ensure interior flexibility and large window areas, facing southwest, strengthen the clear space concept and provide great exterior views. To promote diversity, all flats in the addition of storeys, including the common rooms and roof terraces, as well as many of the existing flats, can be accessed by lift via barrier-free pathways. Our adaptable interior design of the flats ensures barrier-free use for multiple groups of people, thus adding to our sustainable concept.

Compensating for a reduction in flat area, our design offers generous communal areas for all residents of the building and ensures greater cohesion within the neighbourhood. These areas are always located near the staircases and are easily accessible from these central building hubs. Green spaces on the roof can be used for relaxation and leisure activities.

2.3 Climate

Changing weather conditions, which include an increase in localised heavy rainfall, but a decrease in the total amount of precipitation per annum, often lead to a sudden overload of sewer networks, water supply, and sewage treatment plant infrastructure. Increasing "soil sealing" of undeveloped land through urbanisation and new construction also disrupts the natural flow of rainwater. To avoid these problems and their associated high costs, alternative solutions need to be integrated.

Rainwater collected from the building's roof is used to irrigate the extensive greenery mentioned before. This ensures resource-saving irrigation with the optimum degree of water hardness for the vegetation. In dry periods, greywater provides the necessary water for irrigation. The rainwater tanks are combined with greywater treatment systems so that precious drinking water is not wasted even during dry periods. Used shower and washbasin water is collected in this system and purified to drinking water quality, which can then supply washing machines, cisterns, and toilet tanks. Greywater treatment systems can save up to one-third of the potable water in buildings. If the rainwater tanks reach their maximum capacity level, for example during a heavy rainstorm, excess water is then fed and dispersed directly on-site through a drain field system.

The building's rain gutters have three tiers of gutters for various rain scenarios, and overflowing drain water is emptied out onto the property during torrential rain.

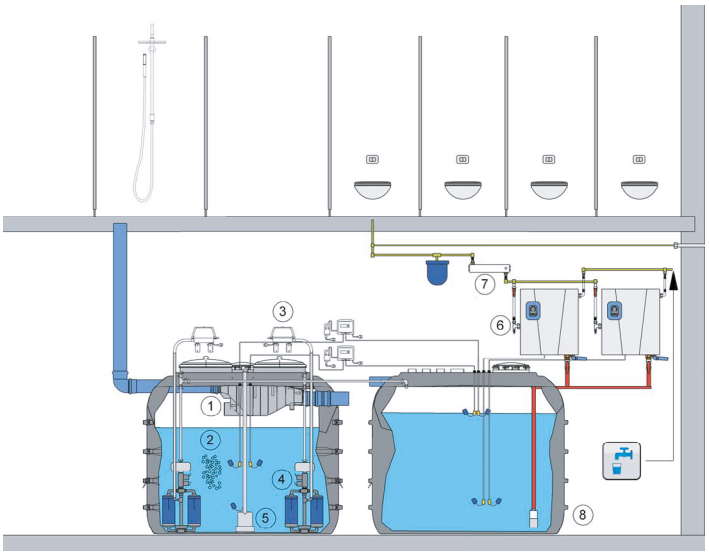

Figure 4 – geywater treatment

The existing building will be renovated with a new "activated" façade, which will effectively use the large thermal storage mass of the façade to collect and store thermal energy. Heating circuits are installed between the existing walls and the new insulation layer so that we can achieve a low-energy temperature control with active conditioning of the interior spaces.
In winter, the basic thermal load is covered by façade activation. In summer, the night-time cooling capacity of the PVT collectors on the roofs and facades can be used to redirect heat from existing walls. Cooling at night creates cold storage which can cool the addition of storeys during hot summer days.

2.4 Durability

The ceilings of our wooden modules are self-supporting and guarantee variable floor plan use. The interior walls in the residential units are non-loadbearing and a uniform room height of 2.40 m facilitates reconfiguration when necessary.

Our addition of storeys modules can be assembled and disassembled quickly and efficiently. Retrofitting energy systems on the façade is also simple, as the BIPV panels can be removed separately. Manufacturer take-back programmes at the end of the life cycle promote a circular economy, and collaboration with life-cycle analysis software facilitates this process.

Damage-free maintenance and easy replacement through permanently accessible wiring are required because we are developing „levelup“ as a modular, fully pre-installed „plug & play“ system. After the competition in Wuppertal, the HDU will continue to be used as a day-care centre and family office at TH Rosenheim campus.

Cables and utilities are located behind removable wall, ceiling, and floor coverings, and in freely accessible ducts. Electrical lines run through skirting boards and can therefore be retrofitted at any time. Switches and pushbuttons are radio-controlled, so there is no need for subsurface cabling, channeling, or ductwork in the walls. The clay wall cladding is attached directly to the solid wood wall, which provides a high thermal mass and optimal thermal protection in summer. The wall and floor cladding of the bathroom is mechanically fixed and quickly removable. The cladding can thus be replaced without damage and pipes and utilities are easily accessible.

2.5 Building Materials

In our “levelup” system, we attach great importance to short transport routes, fast assembly times, and sustainable and recyclable materials. Therefore, we use wood as a primary building material for both exterior and interior construction, because it can be harvested, processed, and installed regionally, and because it is much lighter than most “standard” construction materials, i.e., steel and concrete. Actually, we have designed a vast majority of the entire addition of storeys and the new façade out of wood and lightweight wood-based materials. Wood as the primary exterior material repeats itself in our interior construction, where the acoustic ceilings are made of silver fir and fitted with softwood fibre insulation. The flooring is a regionally harvested and processed ash parquet.

Prefabricated modular elements made from wood and wood-based materials greatly reduce construction time. To adhere to set transport sizes and regulations, all wall and roof modules are designed to fit exactly on transport lorries. Standard timber cross-sections ensure easy re-use in the construction sector. All of these factors greatly reduce CO2 emissions and support climate-neutral construction.
All interior materials are moisture-regulating, ensure a pleasant and balanced indoor environment, and are free of or low in pollutants and VOCs. For instance, the interior walls are clad with Claytec® clay wallboards and are 100 % recyclable at the end of their life cycle. Here we use double planking which guarantees us a fire-protection class of 5 in Germany. No painting is required because the clay plaster will be pre-pigmented with colour. However, apart from the use of clay, we have attempted to dispense with all mineral-intensive building materials. Except for required foundation work, no concrete will be be used.

Apart from wood as a primary material, the structure that has been designed to carry our stairs, lifts, arcades, and balconies, which will be built on the garden side of the existing “Design Challenge” building, will be made of lightweight steel.

The filler used as sound insulation in the hollow-box ceilings will be made from the shredded roof tiles from the existing building. Besides reducing noise, this helps to avoid waste and saves grey energy.
All wood materials - floor, ceiling, and furniture - meet the high requirements for pollutant limit values of the „Blue Angel“ certificate, and no environmentally harmful coatings are used on exterior components. The curtain walls are either covered with glass BIPV modules or clad with oiled wood. Our building is, therefore, user and environmentally friendly.

Figure 5 – Fastening the clay building board in our HDU

Figure 6 – Putting clay plaster on the building boards

Rosenheim Technical University of Applied Sciences

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WUPPERTAL GERMANY ...goes urban!

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