levelup

levelup your ...

# Architecture

## Jury Brief Report #1

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

Technische Hochschule Rosenheim

# 1. The neighbourhood

## 1.1 Site integration

We see the most significant potential for housing expansion in an urban context in „renovation & addition of storeys". Therefore, we create affordable new living spaces without sealing land and at the same time contribute to the German government's goals for a climate-neutral building stock by 2045. In this way, more than 1.1 million new flats can be built in German inner cities. With 77% of the German population already living in cities, and the trend rising, new affordable housing is needed in urban areas. Our addition of storeys is to be constructed in a sustainable and carbon-neutral manner using timber modules. Our system is designed to be flexibly applied to typical residential buildings from the 1950s to the 1970s. They make up the largest building stock in Germany, are in dire need of renovation and have high energy consumption. With levelup, we can make a significant contribution to the climate neutrality of our cities.

Our Design Challenge was developed on a building in the urban situation of Ludwigsfeld, which belongs to the Siedlungswerke Nuremberg (state housing association in Bavaria). Levelup provides multifunctional and communal indoor and outdoor areas, creating new social hubs for the community and enabling a future-orientated transformation of the urban situation.

### 1.1.1 Ludwigsfeld

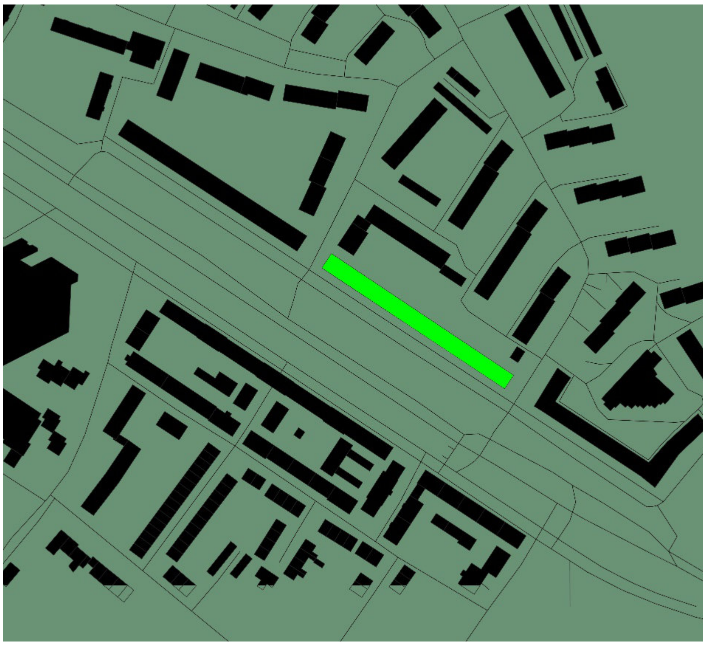

*Figure 1 – Ludwigsfeld and in green marked the building from the Siedlungswerke Nuremberg for the Design Challenge.*

The urban district Ludwigsfeld, in the south-eastern part of Nuremberg, is characterized by a very heterogeneous population. North-east of Regensburger Street, elongated apartment blocks dominate the urban development. In general, the metropolitan area looks very depressing and grey. There is a lack of places for leisure, culture, sports and recreation in the chosen neighbourhood. Our extension offers these components and can thus contribute to a successful and innovative neighbourhood concept, as the potential for positive change is very high.

### 1.1.2 The residential extension

We present a system that efficiently identifies existing inefficient development structures. With our adaptable modular building system, ordinary buildings from the 1950s to 1970s can be added by storeys, and the existing building renovated simultaneously. We see this universal applicability as a particularly unique selling point.

The positive aspects of modularity and flexibility also extend to the residential levels and manifest themselves in self-sufficient quality of life for all generations. The concept also reduces construction time and costs. Since no land has to be financed for the construction, the system is also financially very lucrative.

*Figure 2 – The entire neighbourhood will be greened, creating a healthy climate and strengthening biodiversity. The shared areas on the roof create a strong community.*

The living space is extended vertically so that no additional green areas need to be sealed. On the contrary, new green rooftops are created above the residential storeys to strengthen biodiversity and create a healthy microclimate. The measures also counteract the heat island effect. Moreover, the new floors create places for people to spend time and communicate in the neighbourhood. This creates an excellent starting point for a new generation of neighbourly living between different age groups and helps to avoid alienation.

# 2. The whole building - design challenge

## 2.1 Design of the building

### 2.1.1 General

Our competition entry aims to develop a transferable and adaptable system for as many use case scenarios as possible, not to design only a single solution. The „levelup“ system aims to upgrade existing buildings and transform them into climate-neutral building stock.

### 2.1.2 Concept - The „levelup“ system

„levelup“ was developed so that it can be flexibly adapted to recurring building characteristics of residential buildings, with typical building depths of 9 to 10.5 meters, but regardless of the length, buildings with concrete ceilings, with load-bearing exterior walls and a load-bearing interior wall. We have chosen a modular system consisting of transportable, fully equipped wooden modules with the following dimensions: length 7.50 metres x width 2.95 m x height 3.10 m. The arrangement of the modules is subject to a strict grid. The staircases represent constraint points. Between them, the modules are arranged so that the maximum number of room cells can be arranged and end with a „gap“ to the staircase. These surplus areas do not contain prefabricated modules and can be used as desired, e.g., basement replacement.

### 2.1.3 The Architecture

Our addition of storeys crowns the existing building with its asymmetrical gable roofs. The more extended roof surface faces southeast and is equipped with PVT collectors for energy generation. The opposite side accommodates green zones in roof terraces and greenhouses. Below are two levels of prefabricated room modules for the living spaces.

*Figure 3 – Building Elevation southwest and northeast*

Compensatory areas are zoned into communal areas and storage rooms. On the street side, the generous openings of the extension contrast with the perforated façade of the existing building. Access is via an exoskeleton on the garden side. Five staircases are relocated to the outside and offer barrier-free access to the existing building and the addition of storeys using elevators. In addition, arcades connect the staircases at the height of the extension and ensure flexible horizontal connection. New balconies – fixed in the exoskeleton of the existing building - provide more living quality. The solar systems are an integral part of our design. To generate the maximum photovoltaic area, the entire high-yield south-west and south-east façade of the existing building and the addition of storeys are covered with collectors. The curtain façade elements shape the design of the existing façade with a free joint pattern and conceal the technology behind them.

*Figure 4 – The new height of the building opens up new potential for the use of solar energy.*

The concept aims to respond to the needs of the residents with innovative, economic and small floor plans. The flats are made up of two or four modules. This results in flat sizes for diverse groups of people, 36.7 m2 and 77.9 m2, respectively. The per capita living space in our upgraded apartments is about 21 m², less than half the average living area in Germany. Accessibility offers a new perspective for many people, and the interior spaces can also be adapted to the needs of the residents.

Communal spaces result from the surplus areas in the grid, which means they are always located near the staircases. All residents can use them, they are fully glazed, and the greenery creates greenhouses that can be used all year round. Vegetation plays a crucial role in our design, both inside and out. After the transformation of the neighbourhoods with the „levelup“ system, there will be more green spaces than before the “re-densification”.

### 2.1.4 The structural solution

The structural realisation of the addition of storeys is based on modular timber construction from sustainable forestry. The exoskeleton for the access on the garden side is made of recycled steel. The existing building forms the base for the addition. The existing roof is removed, and a load distribution level is formed on top. Its girders span from the load-bearing outer walls as two-span girders over the load-bearing middle wall. The prefabricated modules of the addition are transported to the construction site and placed on the load distribution girders.

Horizontally, the modules are butted through an insulated joint between two solid timber walls. Vertically, the module ceiling and module floor always form a ceiling package. This decoupling of the modules ensures a high level of sound insulation. The walls are made of stacked board elements with diagonal formwork. The ceilings and floors are designed as hollow box elements. This offers the advantage of large spans with low material usage. Cases, ducts and pipes can be laid in open spaces.

In addition, these are filled with shredded roof tiles from the existing building for increased sound insulation, thus avoiding waste debris and saving grey energy. To comply with fire protection class 5, the walls must be encapsulated. This is done in two layers with 22 mm thick clay building boards. The ceilings are exclusively self-supporting and designed to be fire retardant. The roof surfaces consist of trusses that support the sheet metal roofs with the PVT collectors and the glass roofs of the common areas.

## 3. The House Demonstration Unit

### 3.1 Architecture Concept

The HDU shows a representative section of our „levelup“ system and our Design Challenge (DC) extension. Due to the competition conditions and our location on the Solar Campus in Wuppertal, adjustments had to be made compared to the DC. The roof orientation of the House Demonstration Unit (HDU) is rotated by 180° to align the roof PVT system with the sun according to the location. The flat is shortened by one wooden module, and the louvred façade and pitched roof are set back by one module width to remain within the solar envelope. This results in changes to both the external appearance and internal structure of the HDU compared to the DC. However, the basic principle remains the same. The HDU is accessed at the competition from the street via a ramp to make the height of the wooden platform barrier-free. Our design shows an accessible flat with a very open floor plan. The free space without load-bearing walls can be freely furnished and designed. There is a barrier-free bathroom and bedroom next to the large room with a kitchen, dining, living and working space. Both rooms can be easily adapted for use with wheelchairs because the goal is to create living spaces for all people. For good use of daylight, there is extensive glazing in the living area facing south. We use recycled vacuum hybrid glass for the windows. The Public Tour continues outside via a second exit to the southwest. Visitors reach the upper floor via a staircase. In addition, we provide a lift for barrier-free access on the northeast side. The entire HDU must be barrier-free for all audiences to experience independently. Our communal areas - greenhouse and roof terrace - are located on the upper floor. Roof greening and social interaction spaces are made tangible for the visitors on the upper floor.

*Figure 5 – House Demonstration Unit*

### 3.2 Interior Design

Our HDU consists of a bright, barrier-free floor plan for two people with a spacious bathroom and separate bedroom with an integrated workstation in the partition wall designed as a built-in wardrobe. The fold-out space-saving second workstation in the living room makes it suitable for a home office for both residents. Accessibility is ensured by 1.50 m at the main functional points and 90 cm door width and sliding doors. All built-in furniture such as kitchen units, kitchen island, wall cupboards and wooden partitions, and the complete bathroom with its removable wall panelling in the wooden modules, including all wiring, are delivered to the building site pre-assembled (plug and play). The module connection joints on the wall and floor also serve as installation channels, which remain easily accessible for later cable retrofitting via magnetic locks.

Together with the electrifiable skirting boards, this ensures future-proof cable routing without slot tapping. The socket boxes located on these skirting boards can be placed according to the tenants' wishes with little effort in the event of a change of tenants.

*Figure 6 – Interior view of the HDU / Living area and entrance*

## 3.3 Lighting Design

### 3.3.1 Natural lighting concept

The focus of daylight planning is on people, their well-being and their health. For these reasons, daylight has been essential for architectural planning. The living area is supplied with sufficient sunlight through the large southwest window. As part of the optimisation, various degrees of reflection were tested, e.g. for the floor covering and the surfaces enclosing the room. On the north side, the construction and materiality of the pergola could be revised for the best possible daylight incidence. The minimum requirements of DIN EN 17037 and the competition requirements are met.

### 3.3.2 Artificial lighting concept

In the outdoor area, the design motif of the light line runs through the access areas of the HDU. The linear luminaire type from Insta Lighting is used in all handrails of stairs and ramps and ensures sufficient brightness. For horizontal access, luminaires are mounted around the perimeter walls. The luminaires are placed at a great height to ensure adequate luminous flux. It is glare-free in the longitudinal and transverse directions, no light falls into the extended surrounding area of the HDU. The impact on animals and plants from night-time lighting is thus minimised. Presence detectors are planned for subsequent use in Rosenheim, equipped with the principle of „dynamic light". The light line is also repeated on the greenhouse in the area of the roof structure, and battery-buffered portable luminaires provide individual lighting for the roof terrace.

Trends in interior lighting clearly show the users' desire for individual lighting. However, the classic „ceiling light" has lost none of its importance. A variety of floor plans and furnishing options were examined to identify the position for recessed, surface-mounted or pendant luminaires. At these points, a self-developed mounting box is permanently integrated into the ceiling of the HDU, which can then be activated by the users as required. Light sources and luminaires are oriented toward high-quality visual tasks in the living, cooking, and dining areas. Downlights with GU10-based light sources from Soraa were chosen. These are characterised by outstanding colour rendering properties.

In addition to light quality and atmospheric effect, criteria such as sustainable and social aspects were also considered for other luminaires.

## 3.4 Solar System Integration

For energy generation, our HDU has three differently oriented PV systems, consisting of PVT collectors on the roof (3.750 kW, 18.8 m$^2$), semi-transparent PV modules (1.486 kW, 13.3 m$^2$) on the top of our greenhouse and building-integrated photovoltaics (BIPV) on the façade (4 kW, 27.9 m$^2$). The intensive use of solar energy and the various technologies integrate into the overall architectural picture and shape the concept, parallel to many technical aspects. Due to the different module orientations, a balanced generation load profile is possible throughout the day, which means that the capacity of the energy storage system can be selected to be smaller than a purely southern orientation.

The double use of the surface is essential in our concept: The PV modules provide shade on the greenhouse and generate electricity. Besides electricity, the PVT modules also generate heat during the day and cold during night-time. The recovered heat from the collectors is used for heating and hot water. The cold is supplied during the day via underfloor heating and cools the rooms. The removal of the heat at the collectors also increases the efficiency of the solar cells. Module prices for the systems have fallen significantly in recent years, and BIPV has also established itself on the market.

Due to the very low maintenance requirements and extended performance guarantees, it is impossible to imagine the energy transition without solar technology.

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