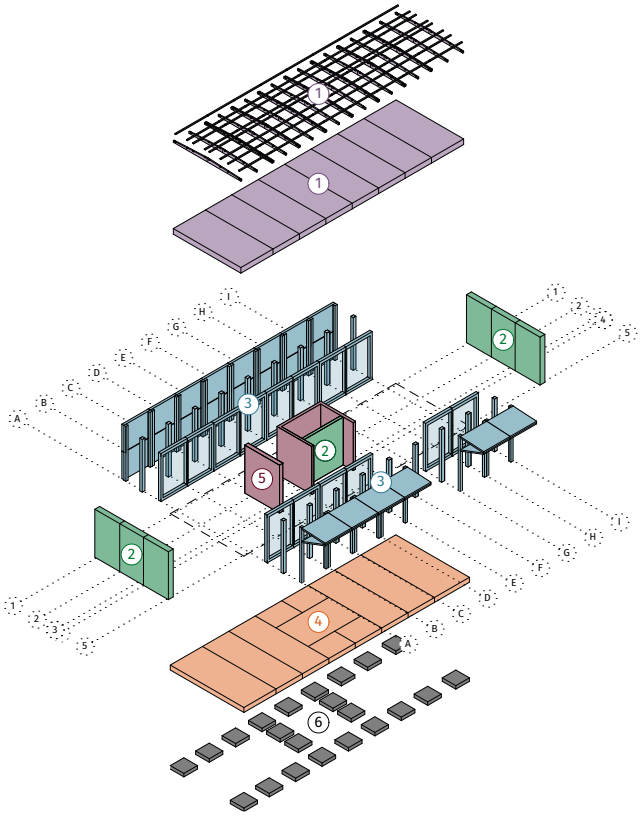
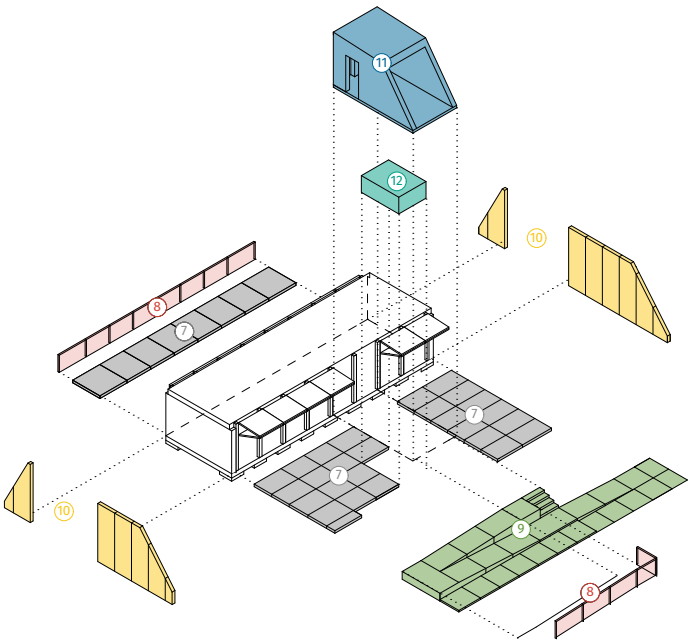

ROOFTOP
CONSTRUCTION
ENGINEERING
Solar
Decathlon
Europe
berlin

Many amazing architectural concepts remain just that. Concepts. Our universities are no strangers to the divergent curricula of architects and engineers. Project Rooftop is a student-driven effort to change that. We design side by side — one house, one team.



STRUCTURE

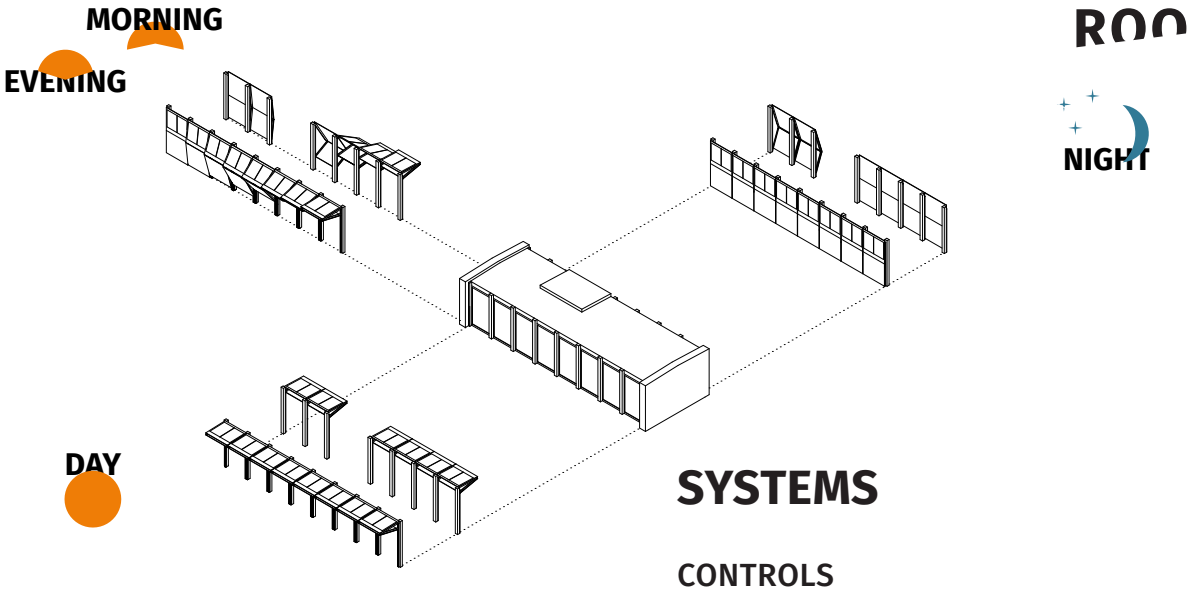
First things first. Everything, be it feathers or electrical installations, has to rest upon something. The structural safety of the Rooftop House is ensured by wood, modular (steel) connections, and night-long calculations. Our main structure is entirely made out of local wood. As usual, deformation rather than bearing capacity were decisive for the dimensioning. For instance, smaller pillars would easily carry the roof, however, the movable façade's low tolerances result in the chosen 20x16 cm profile. The two gable walls and one wall between kitchen and mechanical room (green-coloured walls in the blow-up, #2) brace the building against wind loads.



ADAPTABILITY & CONNECTIVITY

Other than many concrete boxes standing around in Berlin, our house is constructively designed to be test-built, disassembled, transported, built in 10 days, disassembled, transported, built for... well, not exactly eternity, but longer than a three-week competition.

Our connections are designed not to loose capacity throughout the multiple building processes. Instead of screws we use Rampa-Muffen and bolts wherever constructively possible — an exception being the bracing wall behind the kitchen is part of the Core Module, which never is disassembled: screws are perfectly fine here. Our wooden dove-tail terrace connections avoid steel altogether, in line with century-long carpenter traditions. Bracing the mock-up Brandwände (yellow, #10) at the long sides is achieved applying weight below the terrace. The most adaptable feature of all, however, is the moveable façade. Its deformation tolerances could only be met with metal,



to keep things light we opt for an aluminium frame. The lifting movement is realised with two cable winchs inside rails fixed on the neighbouring wooden pillars. The lower wing's base is fixed on these cables, the motor's actuator force is translated into movement here. A shaft connects the motor to both rails. The upper wing is connected to the lower with a bolt, and to the house with a hinge at top.

Why the engineering effort?

Nature has a distinctive rhythm; day and night, summer and winter. Our clothes do, too. Our houses often do not. The engineering innovations of the past have disconnected us from nature; light is paramount at night, and smartphones never sleep. It is time to recognise that dead fossil fuels cannot keep us up at night forever. Our façade tries to lead the way here: wide open on a sunny day, its solar panels reach maximum efficiency (the façade constantly placing them 90° to the sun) while shading the living space. The cooling system is relieved, the living space flows into the sky. The other extreme is a very cold winter night: the closed façade, equipped with a wood wool insulation, envelops the house like a cocoon and increases its heat resistance. If the winter sun blesses Berlin (rare enough!) sun rays, impossible to work their charm with conventional, fixed insulating systems, reach the Rooftop House.

SYSTEMS

CONTROLS

Of course, an adaptable system needs to be adapted. The user rules supreme, pushing a button in the Core Module or on his phone. The entire building system is controlled and monitored through a central unit.

ELECTRICS & PHOTOVOLTAICS

Myriad electrons make it all possible. And the sun. Our photovoltaic system unites performance-oriented engineering and aesthetic architecture. The Berliner Altbau provides a clear context and our roof ridge does not exceed the local norm, integrating into the roofscape. In turn, the 60°/30° competition mainstay was not an option. Instead, we use a total of 84 120W thin-film CIGS modules, 28 of which are installed on the façades. The movement of the façade can result in partial shading if one panel is open and another closed. To avoid destroying the PV module, PowerOptimizers keep electrical power stable and high by balancing voltage and amperage in a microelectronic process. Even though the façade lifting mechanism consumes energy, the PV panels' optimised position easily offsets this. Over the entire year the PV system produces 11'000 kWh, ranging from 10 kWh on a cloudy winter day to 60 kWh in the summer sun. Instead of using space-intensive lead-based batteries we opt for a $LiFeO_4$ one which consumes 20% of the space at unaltered performance.

HEATING & SOLAR THERMAL

A heat pump in combination with two solar-thermal collectors on the roof provides heat and domestic hot water (DHW) during winter. the best solution for the HVAC system is an air/water heat pump. A centralized concept with one heat pump unit was preferred as it allows to have shorter, more efficient pipes, to reuse the exhaust air's heat and to lower the temperature levels. The temperatures are set at 35°C for the floor heating system and at 45°C for the DHW cylinder tank. The heating system is supported through closing the façade, reducing the glass surface and increasing the heat resistance. The heat pump is connected to two ventilation out- and inlets. The ventilation takes advantage of the Coanda effect to provide fresh air at all times.

The Core Module concentrates all living functions in one place.

COOLING

In summer passive Phase Change Material (PCM) walls and a PCM ceiling, cooled at night by water circulating through a vegetal filter basin, act as cooling system. The PCM is combined with adobe to avoid the hazardous disposal usually associated with it. During the course of the day the PCM modules extract heat from the room, melting into liquids in the process. They are resolidifying overnight because of natural ventilation (which suffices for the walls), while water circulating through the cool grey water basin refreshes the ceiling modules.

WATER

We almost forgot the most essential system of all: providing water for our hygiene and survival. Using Eco-optimising fittings we reduce water consumption by 60%. Our system guarantees constant hygiene due to two factors: the freshwater circuit is entirely closed, there are no dead ends. Grey water is collected in a basin on the northeastern terrace and runs through gravel and reed roots. At the end of the process the refined water is not drinkable but can be used for gardening or washing. Berlin's water quality is very high, and the sewage system has been overdimensioned (4.2 Mio. inhabitants before the war, 3.4 Mio. now); thus, providing water in an urban context and recycling black water is not a challenge.

CORE MODULE

All of the engineering systems come together in the Core Module, which acts as catalyst between and distributor for the different systems. This Core, never to be disassembled, is the heart of the house.

WINTER

SUMMER