Architecture

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U.S. Department of Energy
Solar Decathlon 2017

Swiss Living Challenge

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Towards an urban and energy transition

Global warming and the **depletion of natural resources** are global issues that affect all countries of the world. Indeed, 195 nations signed the Paris agreement during COP21 in 2015, committing themselves to taking the necessary measures to limit the global increase in temperature to a maximum of 2 degrees celsius by the end of the century. The Swiss team is convinced that it is by **acting on different levels**, ranging from the building scale to everyday actions, that we can expect to have an **impact on the planet**.

Switzerland, a small country with a temperate climate located in the middle of the European continent, is characterized by a large mountainous landscape. With more than half of the territory occupied by the Alps, the remaining usable surface is limited.

With this topographic limitation, the population lives mainly in the flatter zones and the urban fabric can be defined as dispersed settlements situated around urban cores. In addition, a 20% increase in Switzerland's population is forecast over the next 30 years[1].

In this context, the **national government has imposed different plans** for the future development of the country. A transition plan has been developed to **increase energy efficiency** and promote the **use of renewable energy sources**, one important objective being to reduce energy consumption by 43 % in 2035 compared to 2000[2]. This position was reaffirmed following the Paris agreements. In addition, to preserve the Swiss territory from urban sprawl, a **territorial preservation law** has been passed in order to allow construction only within the already built-up urban fabric. These two issues have led to the need for an **urban and energy transition** in Switzerland.

🏢	urban area	🌲	agricultural area
🏠	urban sprawl	⛰	mountain area
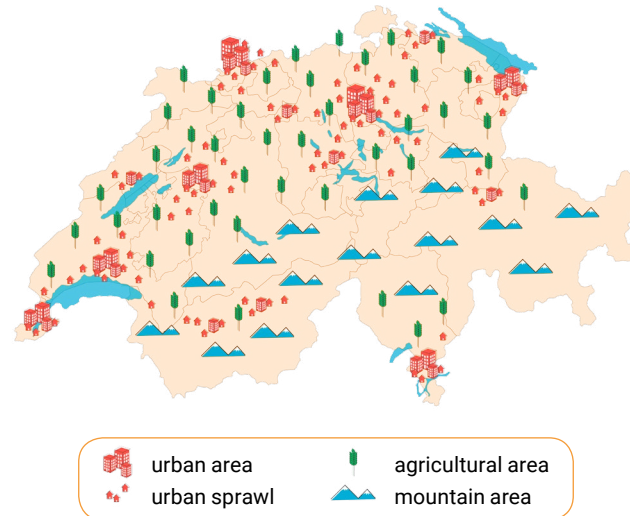
The Swiss team believes that the answers to environmental and social challenges faced by Switzerland and other developed nations do not lie in building an energy-efficient single family house in a residential area. The urban and energy transition can only happen if we work on the **neighborhood scale** by empowering local communities to take on the role of change leaders.

This goal can be achieved by:

- **Putting forward sustainable strategies** to improve building performance
- **Learning by experience** to obtain keys for acting on a daily basis
- **Stimulating a sharing and community spirit**

We propose a place to implement these actions: the **NeighborHub**.

The Neighborhub aims to act as a platform that diffuses knowledge within the community through a learning-by-experience approach. It allows people to **share experiences** and **learn** about the many means through which sustainability can be achieved. The house features innovative technologies which can be explored and understood by "neighbors" during workshops. Through the NeighborHub, we raise awareness among the population, but also provide tools for action.

We identified **seven driving themes** of sustainability that have guided the entire project and are an easy way for visitors to act on a daily basis: energy, water management, biodiversity, waste management, mobility, materials and food.

7 driving themes

A community tool for sustainable neighborhoods

The NeighborHub was conceived to be implemented in different urban areas. The **city of Fribourg** has been chosen as the first Swiss location as it is representative of the country's urban fabric and demographic issues. **Different settlement zones** have been identified, each one presenting different configurations and characteristics. All of them are mono-functional yet have driving themes that, if developed, will enable the creation of sustainable neighborhoods. The **NeighborHub** will be **complementary** to the area in which it is built, proposing specific **services and activities** according to the needs of the respective zone. It will push forward the integration of currently lacking sustainable features in each context and develop solutions to improve energy efficiency of existing buildings. The following types of urban fabrics are widely developed in industrialized countries, which makes the NeighborHub's concept adaptable far beyond Swiss borders.

NeighborHub integration in existing urban fabric

Collective housing and dense residential area are characterized by a high population density and predominantly collective buildings. Hosting a local market and promoting a mobility network (bike or car-sharing system) will reduce the gray energy of food as well as the amount of cars in the neighborhood.

Industrial areas are characterized by the accumulation of factories and industries without residential buildings. The NeighborHub will focus on encouraging industrial waste management and energy production, with PV panels on the roof and façade.

Individual housing neighborhoods are characterized by residential areas consisting of detached single-family houses. Promoting water collection and creating a biodiversity network will help the move forward to a sustainable neighborhood.

Architecture

# Embracing openness and flexibility

From the outside in

In addition to providing a large-scale vision of the neighborhood, the NeighborHub was conceived through an integrated-design approach. It promotes exchange between people by bringing together the seven driving themes in a single, **energy-effective** and **multipurpose building**.

The NeighborHub is composed of two areas surrounded by an envelope: a central and thermally-controlled area called the **Core**, surrounded by a semi-outdoor space named the **Extended Skin**. These two areas complement each other by creating different comfort conditions that fit the activities taking place.

The separation is spatially defined by **four components** placed in a windmill-shaped plan. Each component is composed of **two modules**: one oriented to the Core and one to the Extended Skin.

The Core's modules are supplied with water, electricity and ventilation through the **Technical Donut**, a structural and technical element so called because of its shape. It is placed above the four Core's modules, connecting them to the technical module that faces the Extended Skin. All components are embraced by a wide **modular envelope** that brings energy, light, water and passive heat to the NeighborHub.

Folding doors
Modular envelope
Technical Donut
Module
Component
Core
Extended Skin
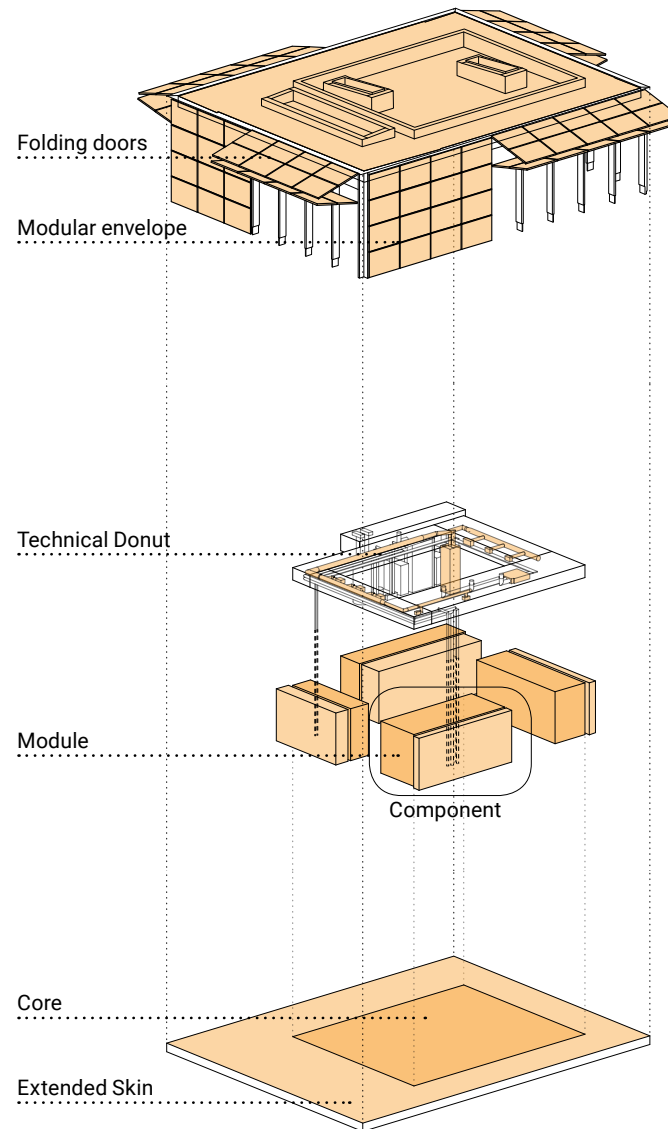
The NeighborHub aims to be a very open and inviting building designed for the inhabitants of a specific neighborhood. This goal is accomplished by its transparency, visual connections and transversality. Transparency is created by the façade, which is either translucent or transparent depending on whether the envelope element is acrylic glass, dye-sensitized solar cells or polycarbonate. Together with a **folding doors** system which offers an extra openness to the surroundings, this transparency creates a visual connection between the outside and the inside that invites people to enter. This concept is enhanced by the Core's four fully-glazed clear-glass entrances located in the corners, in front of the folding doors.

In addition to these features, a "**Talking Skin**" has been set up on the north facade. Visible from afar, it is used for communication. It consists of five polycarbonate modules illuminated by LED light whose color's define the type of activity taking place in the NeighborHub. In this way, the neighborhood's inhabitants can know from the surroundings what is happening in the building and thus be encouraged to enter. The Talking Skin uses a color scheme linked to the seven driving themes: orange for materials and waste management, yellow for mobility and energy, green for food and biodiversity, blue for water management. (cf illustration on page 2)

Embracing openness and flexibility

One size fits all

The project intends to provide an architecture that allows various uses and accommodates multiple activities as a multipurpose space for the community and the neighborhood.

The four modules facing the Core consist of a **kitchen**, a **bathroom**, a **bedroom/lounge** and some **storage cupboards**. The **exchange, gardening and DIY/repair shelves**, and the **technical room** all face the Extended Skin. A seven driving themes color code is applied to the various functions. The shower room floor is painted in blue, that of the dry-toilet room in orange, and the kitchen furniture doors are patterned in green.

The **NeighborHub's envelope** also combines a **wide variety of functions**. What makes it so special is that 100% of its surface has a specific function linked to one of the seven driving themes. It does not only integrate energy production, but also features like water collection, biodiversity, food production and communication. The façade is mainly used for active and passive solar energy with the integration of different elements: **photovoltaic panels** on top of the façade for electricity production, **homemade solar thermal panels** for domestic water heating, and a combination of **acrylic glass** and **polycarbonate panels** to allow light and solar heat to enter. The passive solar energy is used in many ways: It heats the Extended Skin's space for winter and mid-season activities, improves

the vegetation growth in the vertical and aquaponics garden and creates a natural flow for the solar dryer. In addition, **red dye-sensitized solar cell panels** are placed in front of the vertical greenhouses. They filter the light to produce a reddish color that has beneficial effects on the growth of plants as well as providing a warm atmosphere inside. Moreover, the folding doors can be opened during summer to serve as a sunscreen and supply natural ventilation.

The **integration of solar panels on the façade** is made through a strong interdisciplinary collaboration. Architects and engineers put their skills together to achieve a system that combines performance and

aesthetics. By doing this, the NeighborHub shows that solar technologies are no longer intended to be concealed on the roof, but can be an integral part of a building's design. Nowadays, solar technologies go beyond the aim of purely energy production, an example being the dye-sensitized solar cell panels that produce electricity by simulating photosynthesis while being transparent and colored for better integration.

The roof surfaces also integrate uses linked to the driving themes. The **Core's roof** is used for **rainwater collection**, which will then be stored in a tank and used in the washing machine and for gardening. The **Extended Skin's roof** serves as a green area that allows **biodiversity** to be brought back into cities.
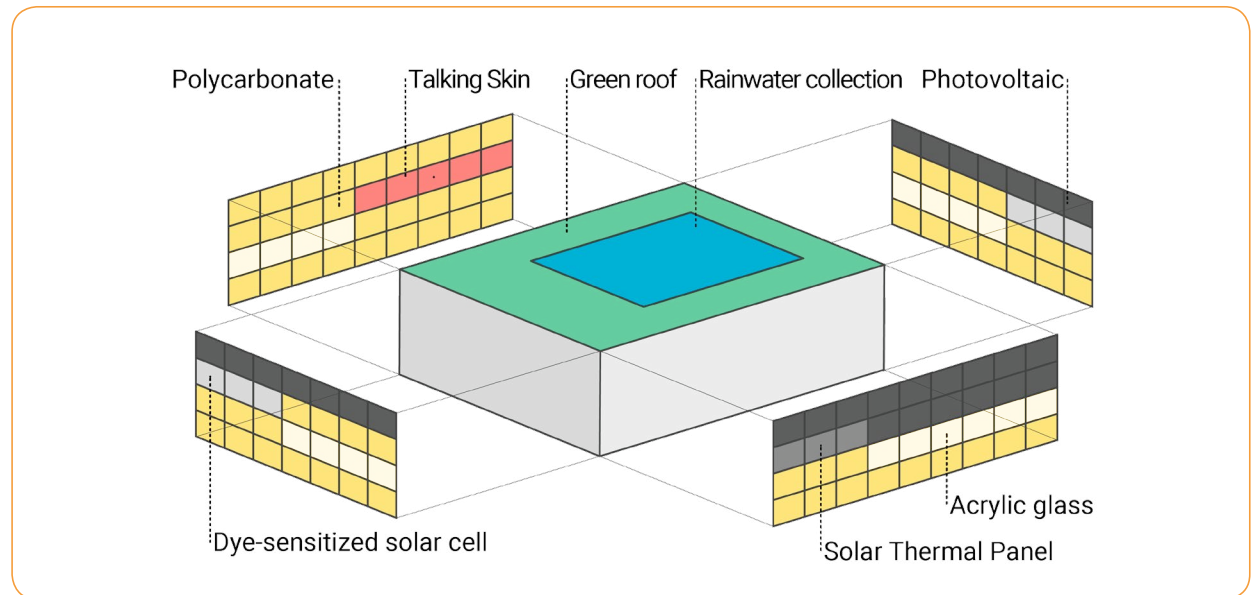
Envelope composition

Embracing openness and flexibility

The whole project works as a **flexible structure**. The proposition of four components enables adaptability of functions and emphasizes the importance of multipurpose space and flexibility.

The **furniture** is also **multipurpose**. For example, the benches, tables, stools and coffee tables can all be folded or disassembled and then stored. And, originally intended to store kitchen objects or workshop equipment, five mobile sideboards have been designed to also serve as worktops or as a support for the beamer.

With their **different comfort conditions**, the Extended Skin and the Core can accommodate a multitude of uses. The Extended Skin, as a semi-outdoor space, proposes comfort conditions adapted to the seasons. Naturally ventilated and protected from the sun during warm days, it is the perfect place to **repair a bike** using the DIY shelves' tools or to simply chat with neighbors about **permaculture** while sitting on comfortable foldable stools. On the other hand, activities such as **conferences on renewable energy** will take place in the Core, where illumination and temperature can be mechanically adapted.

The Core and Extended Skin can work together or separately. We can imagine the former by having, for example, a **gardening workshop** in the multipurpose space of the Extended Skin, while the main space of the Core is used for a **cookery course**. Meanwhile, someone can be reading in the closed-off bedroom.

The journey inside the NeighborHub progresses from the most "public" to the most "private" areas. The NeighborHub is flexible in terms of furniture layout, meaning that spaces are **public or private** depending on needs. The Extended Skin is designed to propose public activities which will emphasize the link with the surroundings and thus be welcoming to the neighbors, while the Core can be made completely private to host a guest.

The house offers a dynamic system through a flexible design that fullfills the requirements for the realization of each activity. By **sharing spaces** between **different activities** at different moments, the NeighborHub proposes a way to optimize the use of land - a key element of urban transition.

gardening workshop · meal · reading · bike repair · conference on water management · housing
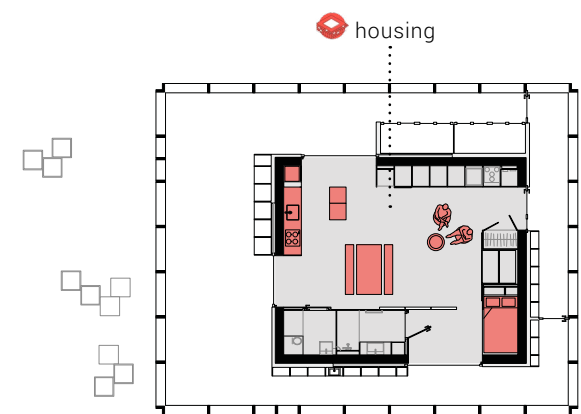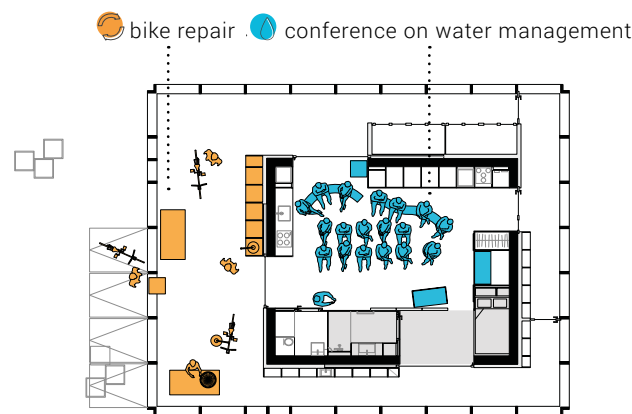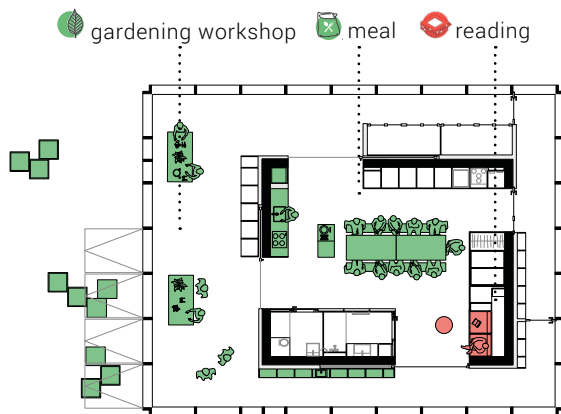
day	evening	night
public	semi-public	private

A low-tech and high-tech approach

Materiality

The materials used to construct the NeighborHub were chosen for their **design flexibility** and were defined from the very start of the house's development. Design choices were made in order to **economize materials**.

The NeighborHub is mainly built with **wooden panels** cut with **Computer Numerical Control** (CNC) machine. **Laminated Veneer Lumber** (LVL) was chosen for its good structural properties and allows the use of a single material for the whole inner part of the building, which offers visual coherence while giving freedom in the design process. It allows the visitor to discover new ways of creating simple building elements with materials they can buy and cut locally. The building blocks for the structural part, as well as the shelves and all the furniture are made of this same material. In an effort to economize materials, leftovers of the cutting process were used to make furniture, while wooden panels could function directly as a finishing layer requiring only a surface finish.

In order to keep the wood texture that creates a **warm atmosphere**, the wooden panels only received a surface finish to protect them from humidity, dirt and aging. All of the Extended Skin is covered with a **transparent oil** to keep the wood as natural as possible and show the material as it really is. In the Core, the modules are coated with **white lacquer** to highlight the four inside modules and to maximize light reflection. The ceiling of the main Core's space and the interior of the modules are covered by a **translucent white oil** that highlights the wood's texture. The floors of the Core and the Extended Skin received the same transparent oil treatment to give a continuity between the two spaces. In relation to the seven driving themes, a **colored resin** has been applied to the floor of the technical room and in the water module to protect the wood against water.

Furthermore, the Extended Skin atmosphere is "**rougher**" than the Core to allow users to work and perform activities without being afraid of dirtying or damaging the space. The **technical elements** are **visible** to show the users how a home really works. On the contrary, the Core is designed as a **living area** where conferences, meetings or dinners can be organised.

The facades are made of different materials. The **metallic frames**, attached to the wooden posts, allow a variety of elements such as photovoltaic panels, homemade solar thermal panels and acrylic glass panels to be integrated.

The most eco-friendly products possible have been chosen for the construction, e.g. **wood wool** for the insulation, paints and oils with **low solvent** content, and even the kitchen and the bathroom countertops made of **industrial recycled material**.

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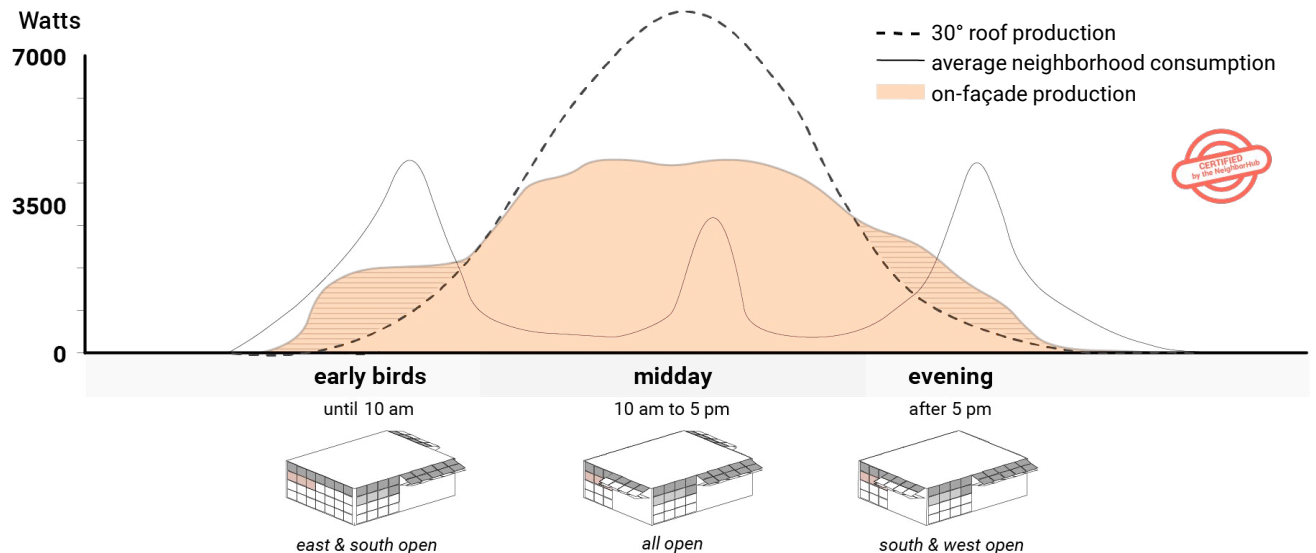
A low-tech and high-tech approach

Energy

The energy strategies of the NeighborHub are an integral part of the design process. The Core is equipped with an **active system**, which means that the heating, cooling and ventilation are set up mechanically. All the information concerning the consumption and production of the building is collected and made accessible to the user by an application called "**Talk to the Neighborhub**", developed for the house and installed on a tablet's. The house is therefore monitored, but not fully automated and allows the users to "**control**" the house. As the NeighborHub also includes an educational dimension, it is important that users remain active and that they act by themselves on the performance of the building. Instead of self-tuning, the NeighborHub sends notifications to users via the application to allow them to **understand and act** on the building's energy consumption.

The Extended Skin, on the other hand, works passively. The arrangement of transparent and translucent panels on the facades allow the space to retain **passive heat** while openable skylights and folding doors offer natural ventilation. The Extended Skin comfort conditions are therefore always better than those outside. Thanks to its modular adjustable façade, this semi-outdoor space can offer **shade**, **wind protection**, **natural lighting** or **ventilation** in order to improve comfort during any season.

Concerning **electricity production**, the NeighborHub is innovative in that it places all of its panels on the facades. **Vertical energy production** is the ideal solution for an urban area in the process of densification as there will be more vertical surfaces available while the roof surface will stay the same. The NeighboHub's facades offer a large area and allow the arrangement of 29 photovoltaic panels, 6 dye-sensitized solar cell panels and 3 solar thermal panels. This layout on the east, south and west sides of the Extended Skin allows a **smoother energy production curve** throughout the day. This configuration produces more electricity in the morning and in the evening, which are the times of the day when energy requirements are highest. In addition, the vertical panels on the south side offer **better production during the winter period**, when the sun's rays have lower angles and strike the panels more directly. Winter is also the season when a house needs more energy for heating. During the summer, the folding doors are meant to stay open and hence give the photovoltaic panels an optimal angle for energy production.

Smart on-façade production

A low-tech and high-tech approach

Natural and artificial light

The natural and electric light concept of the NeighborHub was made to correspond to the need for a **diversity of activities**.

The Extended Skin, with its storage and workshop activities, is naturally highly illuminated thanks to the **translucent envelope** made of acrylic glass and polycarbonate panels. Moreover, a **long modular skylight** with semi-automated **shading** has been installed above the wooden structure of the multipurpose space.

On the other hand, the Core allows natural light to enter through **fully-glazed, wide and high entrances** linking the four modules in the corners. This avoids dark corners and ensures natural light enters by at least one of the entrances at any time of the day. In addition, two modular skylights with semi-automated shading have been placed adjacent to two Core components in order to light-wash the wall and thus encourage the visitor to enter. These two strategies allow the provision of sufficient daylight inside the Core.

The **artificial light** concept is based on **different scenarios** where the atmosphere created is optimum for the task being performed. Three variables are used to differentiate one scenario from another: **light intensity**, **light color temperature** and **different light distribution**, thanks to the use of many different varieties of luminaires. The more precision a task requires, the higher the intensity of light will be. Furthermore, artificial light in the NeighborHub reproduces natural light's color temperature, with a high blue spectrum during the day and a warm atmosphere in the evening, all of which are in harmony with the human circadian circle.

The following scenarios are based on the application "Talk to the Neighborhub":

Comfort   provides a light intensity of 300 lux with a warm color temperature;

Working   provides a light intensity of 500 lux;

Cozy   provides a light intensity of 100-150 lux.

We wished the lights to be very **flexible and adaptable**, so there will always be a way to implement new scenarios whose settings can be easily changed in the application.

Concerning the Extended Skin, tubes and spotlights supply the required light. The tubes are placed between the ceiling's structural beams to highlight their aesthetic qualities.
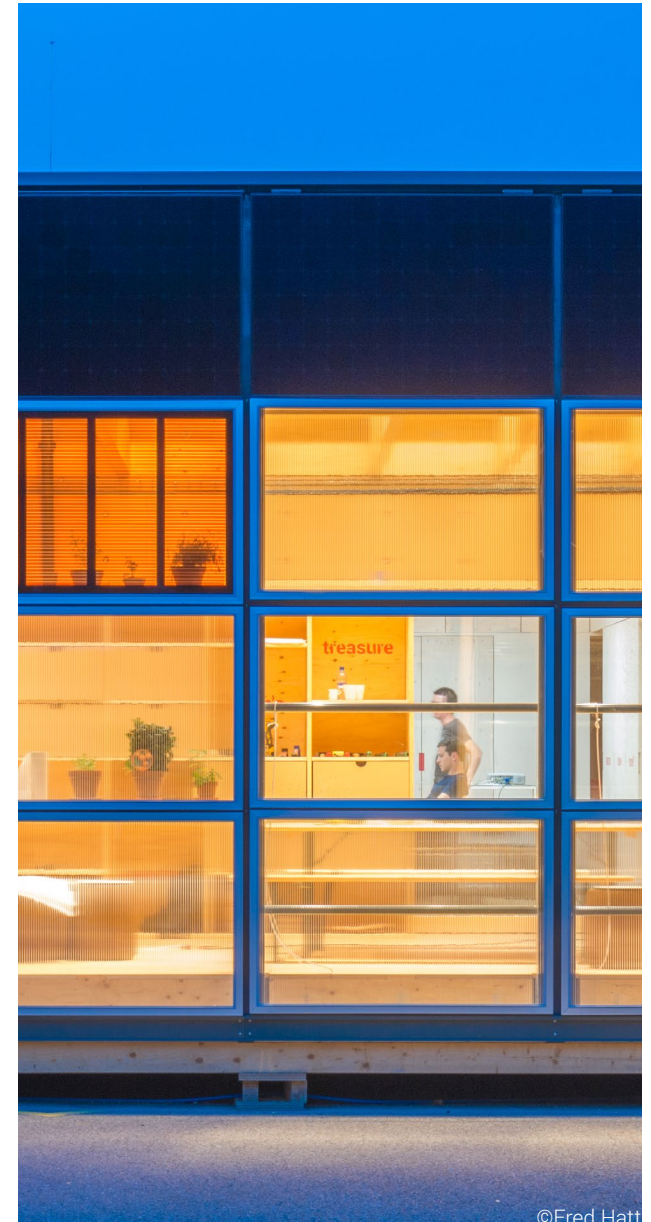
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A low-tech and high-tech approach

Prefabrication and transportation

Within the construction system we have integrated a social dimension, in line with the concept of the NeighborHub. The main goals are short on-site construction time and little need for heavy equipment, in order to allow the neighborhood and future users to take part in the construction process. In this way, the value of the object as well as the sense of ownership by the community is strengthened.

Prefabricated wooden building blocks have been designed to be easily and quickly assembled and dismantled like a construction game so that the house can be built by a partially nonprofessional team. Using LVL panels and a CNC machine, all kinds of blocks can be imagined and built.

The shape of these prefabricated elements is dictated by their function, which makes it easy to distinguish them during construction. In order to make the assembly process simple and fast, all technical elements are installed during the prefabrication phase, which means that the building blocks already contain insulation, ventilation and a plug-and-play electrical system when they arrive on the construction site. The wood makes

these building blocks light and allows constructors to move them on the site without the use of machines. Also, the assembly system, consisting of bearing-type connections and threaded inserts, doesn't damage the wood and makes it possible to disassemble and reuse the building on another site.

In the end , all these parts of the construction system result in a sharp reduction in the total cost of the building thanks to the saving of time on site and the low need for heavy equipment and professional manpower during the construction process .

The design of the prefabricated building blocks also meets the challenge of efficient and affordable transportation, as the NeighborHub must cross the Atlantic Ocean in order to reach American soil. The blocks are as large as possible in order to reduce construction time, but they are also small enough to fit inside a shipping container to be affordably transported to the United States. The transport of wood by boat involves several risks due to humidity. In order to avoid any complications related to the swelling or deformation of the wood, the building blocks have been designed to be very rigid and resistant to warping.
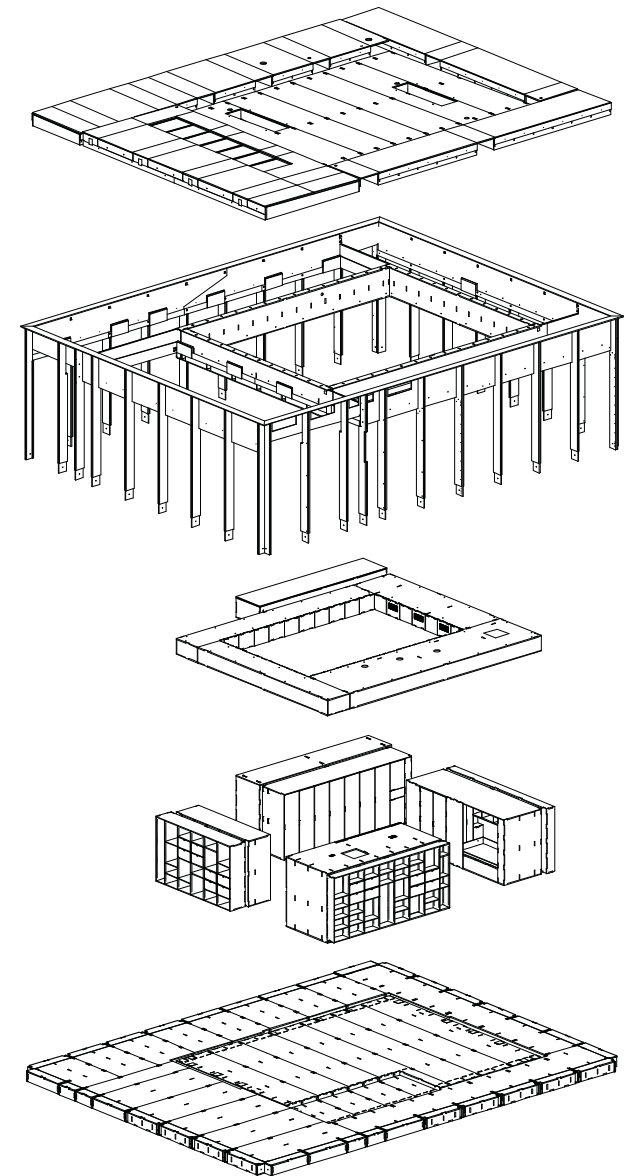

Prefabricated design

The keys to the NeighborHub

The NeighborHub is the bearer of a message that goes beyond the building itself. It allows people from different backgrounds to meet and is the place of creative and sustainable exchange, where users learn by experience.

The sustainable strategies are deliberately highlighted to raise awareness and call for collective change. Without losing their individuality, users can see, learn and share experiences and goods in a place which encourages people to meet and participate in the development of a community feeling.

Through this holistic transmission that gives people the keys for action on both a daily basis and on a building scale, we emphasize that everyone can participate in an urban and energy transition.
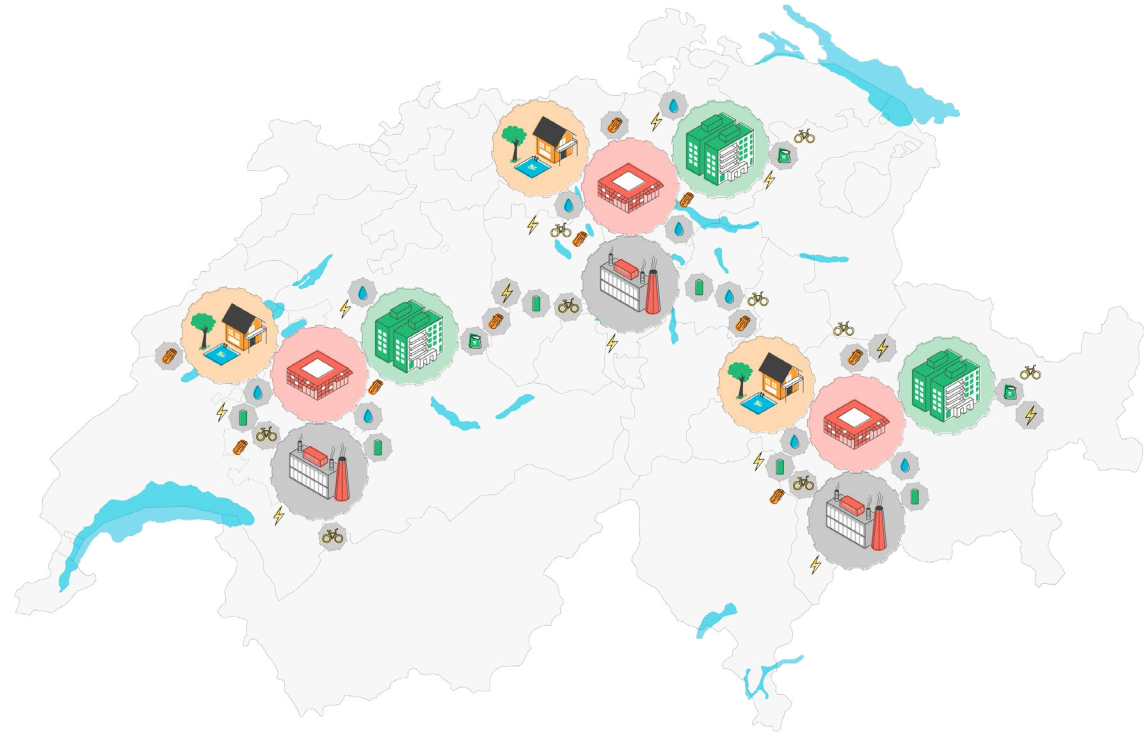
Notes

1   Swiss Federal Statistical Office, population forecast

2   Swiss Energy Law

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