

Project Bauhütte 4.0 – Cluster for innovative construction with wood

Wood is a construction material for affordable housing, an important CO₂ storage source, and also part of Industry 4.0 in Berlin TXL. With the project Bauhütte 4.0 comes the creation, within Berlin TXL – The Urban Tech Republic, of an innovation and production site for a **digitalized value-creation chain called "Forest to City"**. The construction concepts and manufactured components developed in Bauhütte 4.0 are being realized in the adjacent residential buildings of the district.

Schumacher Quartier will provide upwards of 5,000 homes for more than 10,000 people and is expected to become a **model residential district for urban timber construction**. The buildings in the very first construction phase will be built using a minimum percentage of timber of 50%. In this phase, different types of construction, both established and experimental, are expected to be implemented and the timber content in the next phases of construction will gradually be increased.

The term **Bauhütte 4.0** refers to the long period of the Bauhütte Movement and the construction of social housing in early 20th century Berlin. The partners involved in Bauhütte 4.0 are Tegel Projekt GmbH, the Fraunhofer Institute for Production Systems and Design Technology (IPK) and the Department of Urban Planning and Sustainable Urban Development of the Technical University of Berlin (TU Berlin). Six core themes have been defined for the curated site:

Goals of Bauhütte 4.0

- Convert cities into CO₂ storage spaces and promote climate neutrality
- Transform Europe's building culture towards a bio-based, circular economy
- Innovative production processes for scalable and even more inexpensive multi-story timber construction in cities
- Integrated value-creation chain consisting of timber construction, processing, planning, parts production, building, maintenance, and ultimate disposal via the exchange of digital information between all the trades involved
- Promote the Berlin-Brandenburg as a business location by developing a sustainable Industry 4.0 that enjoys global demand

Why wood? The city as a CO₂ storage space

Berlin TXL is becoming a model international location for sustainable construction. All around the world, cities are facing the challenge of satisfying the increasing demand for residential space in a way that is ecologically compatible. With wood as the material, cities become

stomers of CO₂ and building blocks for climate neutrality. For a cubic meter of wood growth, a tree converts a metric ton of the greenhouse gas carbon dioxide and absorbs as much as 250 to 300 kg of carbon¹. In buildings the carbon then remains fixed in the form of wood, a renewable material, for the many decades of its useful life.

Unlike concrete or steel, wood does not have to be produced with a high expenditure of energy and no process-related carbon emissions are created. Thus, by building timber-constructed, single-family houses, up to 35 to 56% less greenhouse gases are created in comparison with traditional materials².

Cornerstone of Bauhütte 4.0 – Industrial-digital value creation chain

With Bauhütte 4.0 in Berlin TXL the project partners plan to make sustainable timber construction usable on a larger scale in urban development as well. In Bauhütte 4.0 an automated production line for the serial production of timber will be developed. Subsequently a value-creation chain, "Forest to City", will come into existence. The aim will be to involve local networks consisting of start-ups, medium-sized timber-construction companies and the forestry industry in Brandenburg. This includes actors from the following sectors:

- Forestry
- Manufacturing
- Logistics
- Assembly
- Housing construction
- Urban planning
- Materials recycling

New value-creation chains provide potentials for innovative products, technologies, and services in the fields of automation and communication technology, and remove any possible barriers to their use in the construction of wooden housing.

Digitalization in timber construction 4.0

Timber construction is to a large extent still characterized by manual production. With greater automation and digitalization, Bauhütte 4.0 is pursuing two decisive strategies in order to erect large numbers of timber-constructed multi-story buildings in cities as well:

Reducing costs in production: It is typical with wooden constructions to prefabricate items for a building that can be assembled on the construction site in a short space of time. However, the degree of automation can be significantly increased for the manufacturing of the components, particularly when assembling parts that are either small or heavy, when

¹ cf. Fachagentur Nachwachsende Rohstoffe [Agency for Renewable Resources]. Available online at <https://baustoffe.fnr.de/bauen/holzbau> [last accessed 11.2.2020]

² cf. Ruhr-Universität-Bochum (inter alia.), 2017: Treibhausgasbilanzierung von Holzgebäuden [Balancing Greenhouse Gases in Wooden Buildings]. Available online at https://www.ruhr-uni-bochum.de/reb/mam/content/thg_bericht-final.pdf [last accessed 11.2.2020]

changing tools on machines, or when bringing in insulating materials and piping. The digital technologies of Industry 4.0 have the potential to further reduce costs for timber construction. Data analysis leads to savings on materials, reduction in machine downtimes, and better documentation of compliance with quality standards, while optimizing the entire manufacturing process in accordance with industrial standards.

Interconnected stakeholders: Wood is a natural product and comes in many variants and quality grades. In particular, it allows for variable construction that proceeds on different principles of planning and construction than with mineral materials. Thus, efficient timber construction is dependent on a comprehensive exchange of information between all participants. By using digital networking, planners, for example, can become familiar at all planning stages with the properties of the wood and the manufacturing possibilities. The tradespeople involved in the assembly can then better decide among themselves how to meet construction schedule times, which in timber construction are basically short.

Bauhütte's mission statement – Building the future together

The name Bauhütte 4.0 is intended to stress the fact that sustainable construction requires rethinking from all stakeholders involved. The “Bauhütte” of the early 20th century were cooperatives whose members came from all kinds of professions and who wanted to find an answer to urban growth by building in a non-profitable and rationalized manner.

The ideals of the city planner Martin Wagner set the example for Berlin. On October 18, 1919, the first “Bauhütte – soziale Baugesellschaft m.b.H. Berlin” was founded. With the construction of the Hufeisensiedlung, the Horseshoes Colony, in the 1930s, Wagner's notions were put into practice in social housing.

In addition, the medieval “Dombauhütte”, where several different trades worked together, set an example for the modern Bauhaus movement. The Bauhaus wanted to break down the boundaries between manual trades, technology, and art. Bauhütte 4.0 complements this concept with Industry 4.0 principles and utilizes the possibilities that digitalization offers for scalable, sustainable construction.

Timber construction in Schumacher Quartier

Bauhütte 4.0 in Berlin TXL – The Urban Tech Republic not only acts as a site for innovative ideas because it is at the same time the construction management center and manufacturing facility for timber construction in Schumacher Quartier. With upwards of 5,000 homes for more than 10,000 people, it is expected to become a **model district for urban timber construction in cities.**

The buildings in the first construction phase will already be constructed with a minimum timber percentage of 50% and this will be successively increased in the subsequent phases. As development proceeds, big cost reductions will be targeted. In Schumacher Quartier

established design principles are being optimized while testing experimental construction methods. The following construction methods for timber are being considered:

- **Panel construction** with inexpensive, interconnected wooden frames
- **Timber frame construction** with beam constructions for open living with transparent façades
- **Solid wood construction** with glued surface structures
- **Hybrid construction** made of wood and with bearing components made of masonry, concrete, or steel

An efficient and safe construction material

Wood is an ideal raw material for a modern bioeconomy because it is a natural high-tech material. High-grade wood is lighter than steel for the same load-bearing capacity. It has a similar compressive strength to that of concrete and can withstand added tensile forces. In modern buildings, because of its high void ratio, wood is also used as an efficient thermal insulator. Nearly zero-energy buildings and passive houses are frequently made from this renewable raw material.

In case of a fire, wood behaves more predictably than other construction materials and is, therefore, rated positively by fire prevention authorities. The state construction laws of the Federal States of Berlin, Hamburg, North Rhine-Westphalia, and Baden-Wuerttemberg now also allow timber construction for multi-story buildings. One task that remains is the further standardization of procedures so that adherence to norms - as is the case with other construction materials - does not have to be demonstrated individually with each project.

Increasing interest in timber construction

In Germany, demand for residential buildings made from wood is increasing from year to year. Around 18.7 % of all new residential buildings were approved³ as wooden structures. High-quality woods, efficient composites, and modern fasteners make building with wood possible even under highly demanding construction conditions. Even so, the use of wood in multi-story buildings remains less widespread. This is why Bauhütte 4.0 and Schumacher Quartier are planning to become a model for urban, sustainable construction with wood.

³ cf. Zentralverband des Deutschen Baugewerbes [Central Association of the German Construction Industry], 2020: Holzbau Deutschland – Lagebericht 2020 [Timber Construction in Germany – Status Report 2020]. Available online at https://www.holzbau-deutschland.de/fileadmin/user_upload/Pressebereich/2020_04_27_Lagebericht_2020/Holzbau_Deutschland_Lagebericht_2020_web_01.pdf