Julian Mauch

Wooden construction in Germany

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Sustainable Building Technologies- Community of Practice' (SBTCP) project

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Foreword

This paper presents the work conducted by Julian Mauch from Münster UAS, Münster, Germany. The work includes wide and thorough research findings from wood construction in Germany. Julian Mauch was as exchange period in Karelia UAS in Autumn 2024. He participated in several courses during that time in Karelia and was close cooperation in Karelia UAS for the 'Sustainable Building Technologies- Community of Practice' (SBTCP) project.

The SBTCP project by Karelia UAS was run in collaboration with Salzburg UAS and Jade UAS aims to enhance the sustainable development of timber construction through using advanced expertise and technologies. The project has three fundamental pillars of research activities: 1) sustainable buildings, 2) material sciences, and 3) building information modelling.

Julian Mauch participated in the "Wood Construction and Wood Construction Products" course during his exchange period, where issues related to wood construction were comprehensively addressed. Since wood construction has been one of Karelia's major focus areas in education and RDI activities for years, it is natural that expertise and knowledge are sought to be expanded internationally as well. During the course, Julian Mauch became more interested in the topic, and it was agreed that he would create an extensive report on the state of wood construction in Germany as part of his exchange period. This work was done in collaboration with the SBTCP project.

The results of the work are now published in this report. The information in the report is highly useful for Karelia's education and as support for RDI activities in future. This has been a successful collaboration activity supported by the SBTCP project and we look forward to continuing the cooperation between Karelia UAS and Münster UAS.
Julian's exchange activities have been supervised by lecturer Timo Pakarinen.

Timo Pakarinen, MML, DI | Lic (For), MSc (Eng.), Karelia University of Applied Sciences

1 Introduction

During the last few years the effects and the reality of the climate change have become apparent and started being noticeable in our everyday lives. Be it the increase in extreme weather events or the measurable increase in global average temperature. With 40% of Europe's total energy demand coming from the construction sector, improvement is definitely needed to have any meaningful chance at reducing the energy and CO_2 demand of the construction sector. When thinking about ways to reduce the CO_2 emissions, often wood construction comes to mind.

Data and statistics are provided in order to shed a light on the wooden construction industry's status and furthermore towards the end of the report how wooden construction can support the sustainability of future construction projects.

This report not only presents recent innovations and projects but also gives evidence about the future of the wooden construction industry and its capabilities and success factors towards a healthier and better use of resources for a more sustainable and environment friendly future of the construction sector.

2 Data and statistics

2.1 Construction in the residential sector

The sector being thought of first when talking about construction is probably the residential sector. The data for residential constructions in Germany shows quite a clear trend: From 18.7% in 2019 of new constructions in the residential sector being wooden constructions, in the year 2023 it increased to 22% (Bund Deutscher Zimmermeister im Zentralverband des Deutschen Baugewerbes e. V. (Publisher) (German), 2024).

In Figure 1 the darker the red it indicates a higher percentage of newly built construction from wood.

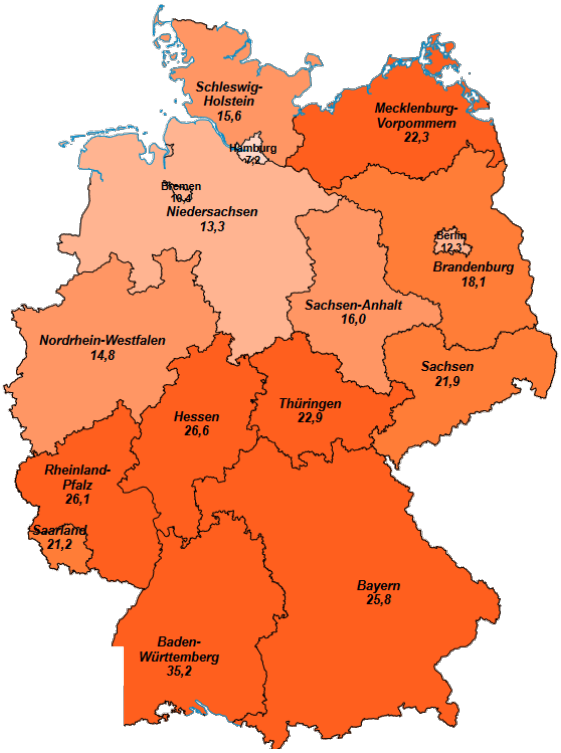

Figure 1: New wooden construction in the residential sector in 2023 (Bund Deutscher Zimmermeister im Zentralverband des Deutschen Baugewerbes e. V. (Publisher) (German), 2024)

2.2 Construction in the non-residential sector

Compared to the residential sector, the non-residential sector includes every other kind of non-inhabited building. Here, construction has an even higher share of buildings made from wood: from 19.5% in 2019 it increased to 23.4 (Bund Deutscher Zimmermeister im Zentralverband des Deutschen Baugewerbes e. V. (Publisher) (German), 2024) in the year 2023.

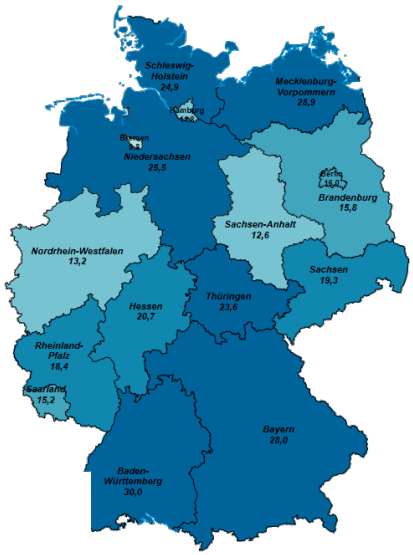

Figure 2: New wooden construction in the non-residential sector in 2023 (Bund Deutscher Zimmermeister im Zentralverband des Deutschen Baugewerbes e. V. (Publisher) (German), 2024)

2.3 Spread of new constructions throughout Germany

As displayed in figure 1 and figure 2 the amount of new construction is not uniformly spread throughout Germany.

Looking first at the residential sector constructions, in general the south has a higher percentage of new construction made from wood compared to the north. There are multiple factors to be considered when trying to explain this difference.

Building category 1	Detached building with a maximum height of 7 meters and 2 utilization units of no more than 400 square meters
Building category 2	Building with a maximum height of 7 meters and 2 utilization units of no more than 400 square meters
Building category 3	Every other 7-meter-tall building
Building category 4	buildings with a maximum height of 13 meters and utilization units of no more than 400 square meters
Building category 5	Every other building including subterranean construction

Table 1: Overview of the building categories (after MBO 2002)

Table 1 contains an overview of the 5 German building categories. Note that the height in meters refers to the highest accessible finished floor elevation.

First there may be a difference in legislation. While buildings of the category 4 are possible without special prerequisites in all States (Nordrhein-Westfalen being one exception), category 5 buildings are different. Here especially southern states like Bayern or Baden-Württemberg have different regulations and requirements. In Bayern for example category 4 requirements have been simplified in 2021. In Germany often cities have either simplified requirements or released guidance papers to help facilitate construction projects in the categories 4 and 5. A notable example here being the "Leitfaden Holzbau" from the city of Freiburg in Baden-Württemberg (Baurechtsamt Stadt Freiburg (Publisher), 2024). It is a good example of a city-adapted guidance. The paper has probably been produced due to the fact that the city is developing a new district which is planned to be made of 90% wooden buildings. This new district will be talked about in the future outlook section of the paper (see section 6). In conclusion legal regulations might be contributing to the spread of wooden construction in Germany. Legal regulations will be addressed further in the following chapter.

An additional element to consider is the availability of wood. Figure 3 below shows the area covered in forest by district. The map shows the majority of German forests including but not limited to: Schwarzwald (southwest, next to the French/Swiss border), an assortment of forests along the Rhein and Main, forests on the Czech border (Sächsische Schweiz, Bayernwald etc.). All of the forests are in states that show an above average construction rate in figure 1. The presence of those forests might lead to a higher rate of wooden construction which makes sense. However, when looking at figure 2 the trend is not consistent: in states like Niedersachsen with comparatively small forest density there is still substantial use of wood in buildings. Ergo just the availability of wood cannot be the main reason for the spread of wooden construction.

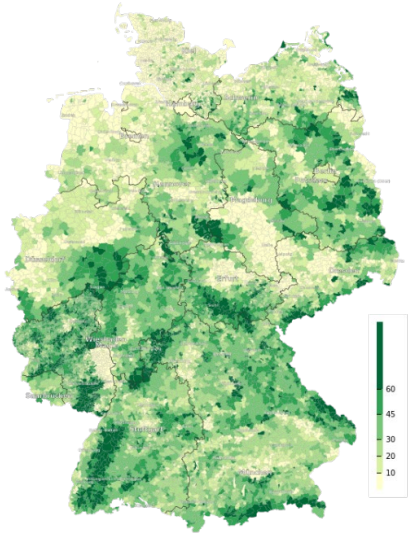

Figure 3: Amount of surface area covered in forests by district

In reality probably neither of those factors can adequately explain the spread of wooden construction in Germany. There are more factors contributing to the spread that can be seen in figure 1 and figure 2. Factors like earthquake regions, local support/demand for wood construction and companies offering wood construction might also have an impact. Explaining and dissecting those further is beyond the scope of this paper, however this article will still focus on examples where wooden construction techniques have been successfully implemented.

2.4 Industry recession?

In addition to the above-mentioned inconsistency, building construction in general is suffering from multiple crises. The absolute numbers of houses built have decreased as presented in the statistics seen in table 2.

Construction Type	2019	2020	2021	2022	2023
Residential	22.284	25.375	27.477	23.359	14.957
Total residential	119.457	124.596	129.309	110.671	67.931
Out of which multi-party	602	837	876	997	887
non residential	5.261	5.674	6.295	5.533	5.520
Total non residential	27.036	27.061	28.971	25.997	23.612

Table 1: Number of constructions in Germany (Numbers after (Bund Deutscher Zimmermeister im Zentralverband des Deutschen Baugewerbes e. V. (Publisher) (German), 2024))

Two big factors are probably contributing to this development. Factor number one is the coronavirus pandemic in 2020. The pandemic disrupted most if not all of the industries, the construction sector was affected a lot harder. Switching to home office is unfortunately not possible for the construction sector, at least for the on-site/factory construction staff. The second and arguably more impactful factor is the Russian war of aggression against Ukraine in 2022. While not only having the psychological impact of disrupting the decades of peace in Europe, it also had the very measurable impact of disrupting global trade, increasing energy costs and also heavily fluctuating (mostly upwards) material prices. The impact of this can be seen in the number in table 2. A slight decrease from the previous year can be seen in 2022 and another very sharp decrease from the year 2022 to 2023.

Interesting to note is that the decrease in houses built is a lot more noticeable in the residential sector. Private owners or rather soon to-be owners do not have the ability to keep up with the rising costs. While bigger companies and corporations are often better equipped to compensate the increase in cost, typically by decreasing the build out. This thesis is further supported by the fact, that multi-family homes, unlike family

homes in general, have not faced the same recession but rather stayed at a constant level.

For the following data it is important to know these two terms. The quick ratio and the equity ratio. The quick ratio is the comparison of the available funds in the short term (money on hand, money owed to the company from contracts and other short time available assets), compared to the short-term liabilities (money owed from suppliers and short-term money lending). A quick ratio of 1 means that all the short time liabilities are covered, while a quick ratio of 2 means they are covered twice, higher in this case is theoretically better. The equity ratio is the percentage of amount of the money in a company that is owned by the owners of the company rather than being loan money from a bank or other creditors. While a higher equity ratio per se does not mean that the company is better off, it usually is a good indication as an increasing equity ratio means that the company is slowly able to pay off debts. The equity ratio is also often used in investments to assess the companies stability.

The quick ratio of wooden construction companies stayed at a steady rate of 2.0 throughout the years 2020-22 and also the equity ratio was steadily increasing from 49.1% in 2020 to 52.0% in 2022 (Bund Deutscher Zimmermeister im Zentralverband des Deutschen Baugewerbes e. V. (Publisher) (German), 2024). Both are signs that the wooden construction companies are still surviving. Considering the significant disruptions and consequences of the two aforementioned factors, this is most likely a testament to the competence and excellent stewardship of the wooden construction companies, rather than the wood construction sector being less affected by the two factors. While by numbers the sector is facing a recession and decrease in volume of contracts, it can be said in conclusion that that is by no means an isolated occurrence but rather an expected recession the same way the entire building sector is facing it.

3 Legal regulations

As already explained earlier in this paper, local legal regulations might have a significant if not the most significant impact. In this section this will now be further elaborated.

As previously mentioned, in Germany buildings are categorized in 5 building categories ranging from 1 to 5. 1 covers buildings with a maximum height of 7 meters, 2 covers the same thing with the difference being that 1 only covers buildings that are detached, both of the buildings may only consist of 2 utilization units no bigger than 400 square meters. Categories 3 covers every other building with a maximum height of 7 meters. 4 covers buildings with a maximum height of 13 meters and utilization units no bigger than 400 square meters. Category 5 covers every other building, including subterranean constructions, that are not special constructions. The height here refers to the finished floor elevation of the highest story in which habitation is possible. For further information see paragraph 2, section 4 of the "Landesbauordnung Baden-Württemberg" (Ministerium für Landesentwicklung und Wohnen Baden-Württemberg (Publisher), 2010) ,the building code of the state of Baden-Württemberg. It is used as an example here, but this section of the building code does not differ in any of the states.

In Germany the building code works on the federal level. This means that while there is a federal recommended building code (called Musterbauordnung or MBO in short i.e. exemplary building code), at the end each state has its own building code (called Landesbauordnung or LBO in short i.e. federal building code).

Originally, only category 1-3 buildings could be made out of wood. With the MBO 2002, however this was changed. The federal building code category 4 can be realized now with wood without a lot of extra paperwork (for example see §24 in LBO-BW). While category 5 is usually possible with some extra paper work, or is made easier with city-level building codes (See Freiburg (Baurechtsamt Stadt Freiburg (Publisher), 2024) as an example). When carefully reading the federal-level building codes, one might notice that there is no direct mention of wood construction per se. It rather is talking about 3 groups of materials (in brackets the corresponding European norm term from EN 13501-2): "feuerbeständig" (R90/REI90), "hochfeuerhemmend" (R60/REI60) and "feuerhemmend" (R30/REI30) (compare LBO-BW).

Usually with a wooden material one would be looking at an R30/REI30 material, the innovation is to apply either a coating or a kind of LVL-panel on top of the load-bearing wooden structure in order to protect the internal structure from heat. The materials mentioned above keep the temperature of the load-bearing wood below 250 degrees Celsius for 60 minutes, effectively becoming an R60/REI60 certified material.

This opens the door for many wooden constructions that previously were impossible. The removal of red tape greatly helped and continues to help accelerating wooden construction in taller buildings, important for the use cases where wood construction is needed most.

4 Relevance in Germany

Bearing in mind the conditions and legislation which in Germany wooden constructors have to obey to, it still needs to be asked what the relevance of this type of building actually is.

Firstly, Germany does have a similar biomass in forests like Finland (eurostat (Publisher), 2023). This means that a similar amount of local wood is available in Germany. Interesting to note is that forests like the "Schwarzwald" are products of wood used for wooden construction. During the 19th century the forest slowly transformed from a mix of broad-leave trees and conifers, in a natural spread (beech trees in the lower elevations and spruce and pine in higher elevations) to a spruce monoculture. This change, mostly caused by a growing need in wood, pretty much cutting down all of the trees present in the Schwarzwald, now has severe consequences.

4.1 The forest monoculture and underlying problems

With a monoculture the impact of a disturbance tends to concentrate in cluster of dead trees close to each other, unlike polycultures in which the disturbance tends to lead to spread-out dead trees, which is less devastating for the entire forest (Larjavaara, 2008). The disturbances here being either pests, fire, storms and other.

This, however, is not the end of the story. In the case of the Schwarzwald for example, the spruce monoculture created another problem. The spruce tree is notoriously known for its negative response to temperature and bark beetles, especially if the tree is already weakened due to higher temperatures or rather droughts, which are often caused by higher temperatures (compare (Waldwissen.net (Publisher), 2019)). This increase in temperature is mostly because of the climate change.

The trees in and around of the Schwarzwald (and other similar forests) are now prime examples of those 2 factors combining, especially because during the aforementioned planting efforts, spruces were placed everywhere, without considering any other important factors, for example soil quality (such as: planting the tree in soil which supports root growth and also considering things like water supply as spruces require enough water). The monoculture in combination with an increase in frequency of extreme weather events, another effect of climate change, and the spruce trees susceptibility to high temperatures and droughts, lead to scenes of large patches of forest regularly being destroyed in storms, by bark beetles and other disturbances.

A good example is the forest called "Harz", it is located pretty much in the center of Germany, a few kilometers south of Hannover. As is probably logical, the forest lacks the

altitude of Austrian forests or the Schwarzwald. Unlike in the Schwarzwald or Austrian forests mentioned in this source (Waldwissen.net (Publisher), 2019), where the effects of climate change and pests are already visible, the Harz shows a lot more dramatic effect. Up to two thirds of the spruce trees in the Harz forest are dying if not already dead (MDR (Publisher), 2023).

Figure 2: Drone picture of the Harz forest showing dead trees (MDR (Publisher), 2023)

As can be seen in figure 4, the Harz is affected severely and very visibly, keep in mind that those pictures are of the year 2022, there is no reason to believe the situation is any better now.

In the situation of the Harz, however, multiple solutions are being discussed such as a forest fires early warning system, changing of forest related laws and reforestation. Reforestation, however, is very expensive and slow especially where instead of just replacing dead spruce trees with new ones, broad-leaved trees are being planted, too.

To support with concrete numbers, the dead area of 2022 is about 21'000 hectares (ha), with about 12'000 ha of those dead trees directly linked to climate change and bark beetles. With the reforestation efforts currently going at a pace of 1'300 ha per year (in the year 2022), about 1'680 ha dying in the year 2022 and considering the fact that of those planted trees, unfortunately 20-30 % do not survive, mostly due to prolonged droughts, the reforestation is currently still dramatically slower than the forest dying.

Figure 3: Drone picture of the Schwarzwald showing dead trees (Tagesschau (Publisher), 2023)

Another study also talks about the Schwarzwald in more detail, while also mentioning the Harz. The study produces multiple interesting statistics and mostly agrees with the findings mentioned in the previous statistics, studies and articles.

The first thing mentioned are base facts. It is again established that a dry and warm environment is the reason trees fare so badly, "high temperature and low precipitation expedite the dying of trees" (Tagesschau (Publisher), 2023) (translated from the German original), says Spiecker in a Tagesschau interview, one of the authors of the study. The already weakened trees then often fall victim to the bark beetles in the end. The novelty in study consists of the fact that the study was able to prove causality between those two factors.

To underpin with more numbers, the study compares the dying of trees now to the dying of trees in the 1990s. Back then, the dying of trees was primarily related to pollutants in the air with about 10-15% of the trees dying, 2-5% tree deaths per year being a normal. In the past years, however, the mortality rate of trees was about 40%, a rate never seen ever before. The study paints a clear picture: the dying of trees is related to an increase in bark beetle population and more directly to climate change (Spiecker & Kahle, 2023). The biggest issue being the bark beetles population which particularly benefits from climate change, as it is now common that instead of one breed per year, there are usually 3 to 4 bark beetle generations bred per year.

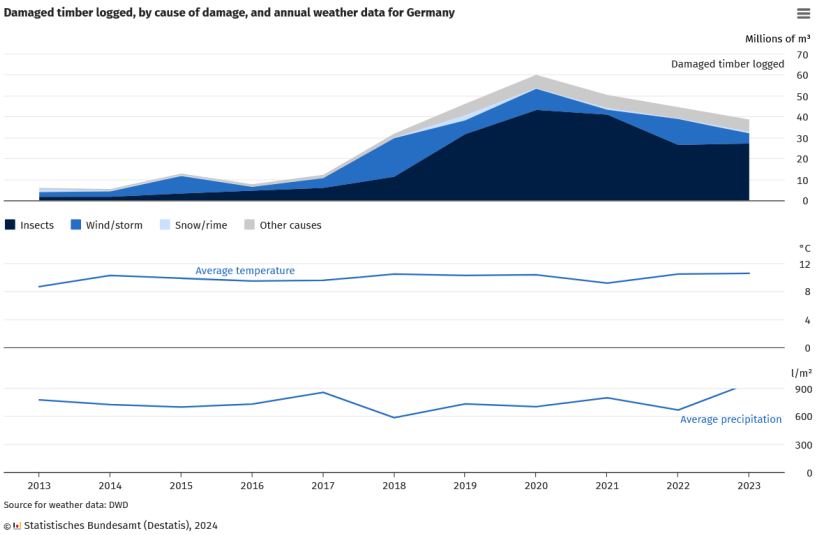

Figure 4: Statistic by the German government office for statistics, showing the amount of damaged timber logged by year and cause

The trend of trees rapidly dying leads to a multitude of problems. While of course the impacts of trees dying are bad for the environment, the forests at some point do automatically recover (MDR (Publisher), 2023), although at a slower pace, as it would just take time until more resilient species grow instead of the old monoculture forest. When planning to transition to more wooden buildings for the construction sector, this does not work. Forests dying and cuttable wood decreasing would result in having to import more wood which is bad for economic independence and also bad for the environment.

Imports of wood are slowly decreasing, however. Over the years, wood import has slowly gone down from about 8.9 million m³ in 2018 to about 5.5 million m³, while exports went from 5.3 million m³ to about 9.8 million m³ from 2018 to 2022 respectively (see (UNECE (Publisher), 2023), page 6 for industrial roundwood), even though as seen in section 1, the amount of wooden construction is continuously going up. This, however, may be due to the fact that more and more wood has to be cut down, because it is damaged and might rather represent a short term trend.

4.2 Wooden construction and its climate benefits

The question may be raised now why wooden houses should be built in the first place if wood is such a limited resource which currently still needs to be imported?

The answer here is of course not a simple one, but rather multifaceted. First the topic of its CO_2 efficiency has to be discussed.

4.2.1 CO_2 efficiency and gray energy

CO_2 efficiency can be measured in multiple ways: The gray energy of a building and the running CO_2 footprint.

When a house is first built a certain amount of energy, water and carbon emissions goes into building this house. The building materials have a certain carbon emission, the machines used in the building of a house have a certain carbon footprint and also the transport and storing of the houses materials have a carbon footprint. All of this combined, from producing of materials to the building steps and everything until the house is complete is considered the "gray energy" of a house. The name probably coming from the color of concrete which is quite common in Germany. It has to be noted here that the definition of the term is not uniform, there exist slightly different definitions, the one mentioned above being the most common one. The running carbon footprint, however, is the amount of energy used during the lifespan of the building such as heating and warm water.

While in older buildings the gray energy usually took up less than half if not even below a quarter in very old buildings, today we usually look at about 2/3 or more of the carbon footprint of a house coming from the initial construction. This is mostly due to the fact that insulation has increased, along with more efficient heating in general, changing the ratio while the gray energy stayed comparatively similar. This is where wood can come into play: wooden houses in general have a lower gray energy than concrete/brick ones, this is due to the fact that wood in general has a negative CO_2 cost, as it rather takes CO_2 from the atmosphere instead of releasing it. In something known as "carbon storage", building a house from wood also has the advantage of storing the CO_2 stored in a grown tree, instead of releasing it when the tree rots or dies.

4.2.2 Multistory and category 4/5 houses in general

Another current problem in Germany is its shortage of housing, the shortage being present in pretty much all kind of housing, be it general housing, subsidized housing or especially student housing in student cities. In general, the housing shortage is a city problem, as more and more people moving to cities causes the shortage, while houses in the countryside get abandoned with entire villages turning into ghost villages.

Wooden construction can help in two ways: first, wood is a good material to build on top of existing buildings. In the city center, it is possible to add an extra floor to already existing buildings, as wood has a good strength to weight ratio. In general, this is a very good way to increase the apartments available without needing more land, useful for cities restrained in space.

Another option where wood can be used is the construction of cost efficient and fast to build construction. Wood buildings can be pre-manufactured in a factory and then delivered to the construction site, as wall segments or even entire building blocks. This is a very good way to cut down construction costs as maintaining a construction site, renting the equipment and paying the employees is very expensive.

This means that instead of taking years to build a multi-story building when using concrete/brick the construction process can be much faster, as an example see chapter (Huber und Sohn (Publisher), 2023), more specifically the 7-story building mentioned there.

Wooden construction is not only being used more and more but also stayed constant during the last few years even with the problems the building sector faced (see table 2 from section 2.4).

In general it can be said that wood is a good material to use for those cases, as it is not only cost efficient but also a lot better in terms of CO_2 than conventional construction. Even though that is the case, it is still very important to keep an eye on proper replanting of forests and also to keep requirements of trees in mind, even if that means reduced wooden biomass growth.

5 Examples in Germany

As a visualization, 5 sites in Germany have been chosen which serve as a good example for the aforementioned demands and use cases for wood construction in Germany.

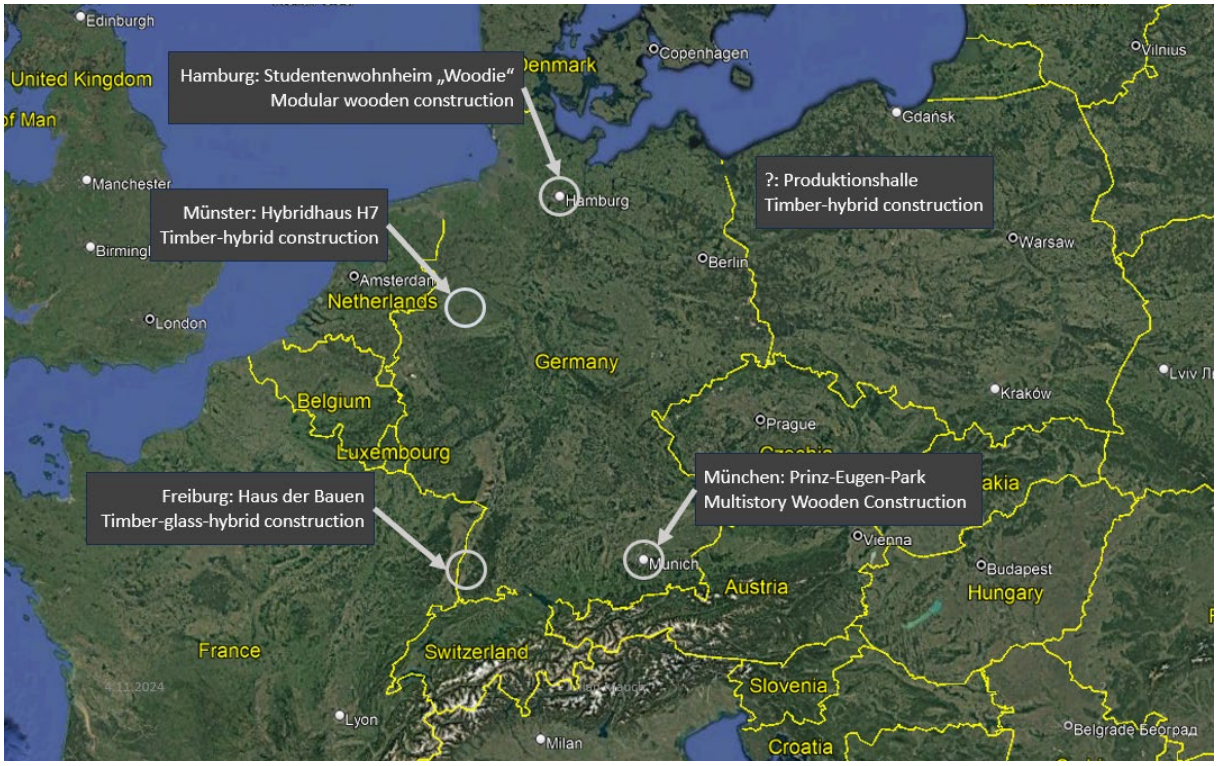

Figure 5: Map highlighting the location of the 5 example sites (Author's own illustration)

5.1 Haus der Bauern in Freiburg

The first example is located in the city of Freiburg in the south of Germany. The city is a known student city which is also reflected in the population. It consists largely of students and younger people and also its international prominence among students. The regional government headquarters of the state of Baden-Württemberg is also located in Freiburg.

The building in question here is located in the southeast of Freiburg in a city district known as "Wiehre". The Name "Haus der Bauern" could be translated as "House of the Farmers", it is named because the local farmers union commissioned this house in 2014 and now uses it as its headquarters.

This house is especially interesting as it uses a novel approach one might also call unconventional. While usually wooden constructions are fully made from wood, this house features a facade made from Plexiglass which keeps water out and protects the load

bearing wood from the elements and by that extends the lifetime of the structure to something comparable to a concrete/brick construction. It is right to point out here that by using different materials, in this case Plexiglass, on a large scale it increases the carbon footprint and also makes it, depending on the material of course, less renewable. The argument here is that the increase in carbon footprint at the point of initial construction is offset by the long term saving of CO_2. The CO_2 saved here mostly comes from the fact that wood needs to be replaced less often, as it is protected from the elements by the Plexiglass.

5.2 Prinz-Eugen-Park in München

Another example is located in München, the capital of the state of Bayern. In this case, it is not a house but rather a city district made from mostly if not entirely wooden buildings.

With about 1800 planned and now mostly built, the city district is comparatively big. Featuring all kinds of wooden construction, ranging from wooden construction to modular constructions and also a hybrid-house, it covers a wide range of building types. The project nicely showcases one of the use cases of wood, being the construction of entire city districts in short time frames and also quite cost efficient used to combat issues like the availability of housing in big cities like München. One notable feat is also the construction of a 5 and 7 story building in just 10 weeks (Compare (Huber und Sohn (Publisher), 2023)).

5.3 Produktionshalle

This example's location is not disclosed but it is likely to be somewhere in Bayern, probably somewhere in the Allgäu area to be more precise.

It is a production facility for a company built entirely from wood. It features 2 production facilities, with the measurements of 100m x 30m and 62.5m x 30m. Their size, however, is not the most important fact or why it is on this list but rather that it has two very interesting new features one could even call innovations. First, the production facilities feature two 16 tonne cranes, usually this would not be standard or possible to be fully built and sustained by just wooden beams, this is a new development which brought the building close to 100% being made from wood. Second, the building is made with F30 (in the EU known as R30) wood, which means, that no sprinkler or building-separating fire safety wall is needed. This again saves costs in both initial construction and also makes the building cheaper to maintain.

This project shows a ground-breaking new development in the sector of non-residential wooden-construction (Compare (Rudolf Hörmann GmbH (Publisher), 2019)).

5.4 Woodie in Hamburg

This site is a good example for another use case mentioned earlier: student housing. The student home known as "Woodie". It nicely presents a good solution for that demand with its cost efficiency and speed of construction.

The student housing unit was built in about a year, quite a fast time for this size of a project. The exact cost for the project is not known, only the fact that 2 private persons invested 37 million €. The house is made mostly from a wooden module construction with the lowest story and the central stairwells made from concrete. While making them from wood would have been possible, it was decided that this was not necessarily cost efficient in this case. With 80 % of the entire house coming pre-constructed (DBZ (Publisher), 2017), it is a nice showcase of how fast and efficient wood construction can be done when properly using the just-in-time principle (compare (Kaufmann Bausysteme (Publisher), 2018)).

5.5 Hybridhaus H7 in Münster

The following building is another example for a non-residential wooden construction, located in the city of Münster in Nordrhein-Westfalen, a student city with 62'000 students in a city of just 320'000 people. The building is mainly an office building.
As the name already implies, the building is a hybrid construction with the foundation made from concrete and the rest of the building being a wood construction. Green glazed ceramic plates are featured in the outermost layer. It was built in about a year during 2015/2016. At its time it was the tallest building in the federal state of Nordrhein-Westfalen. It is 7 stories tall and was calculated to save about 626 tonnes of CO_2 during its construction. A perfect example of an environmentally-friendly construction, a true flagship project for its time (compare (Porr (Publisher), 2016)).

6 Conclusion and future outlook "Dietenbach" in Freiburg

Figure 6: Render of the planned city district (Stadt Freiburg (Publisher), 2024)

Now that the legal framework, the situation and some examples have been looked at, this report will now come to its conclusion and provide a future outlook. This section will cover a new project that is soon to be started in the city of Freiburg.

The project referred to is the new construction of the city district of "Dietenbach" in the west of the city. The area is currently fields and rivers. At the time of writing this, work has already begun in some areas, the entire project is planned to be completed around the year 2040 but as it is normal for projects of this size it may change and is just an estimate. If 50% of the buildings are made from wood, this project is already break even in terms of CO_2, where the wood constructions store enough CO_2 to offset the CO_2-emissions of the rest of the constructions. If 90% of the buildings are made from wood, it is estimated that the district will store up to 200 kilo-tonnes of CO_2. With 50% of the new apartments being subsidized housing, the new city district also covers the earlier mentioned need for senior/student housing. (Compare (Stadt Freiburg (Publisher), 2024))

This new project, however, is not without controversy. There is an entire website dedicated to either stopping this project in its entirety or changing certain aspects of it (see this website of the anti-Dietenbach movement as an example in German). Points are

being made about this project: most often, the cost gets criticized. According to the critics, the city of Freiburg cannot actually afford the housing prices they promise, and especially not the subsidized housing. Numbers and calculations are provided on the website that look sound.

Further on that note, the critics also claim that the housing is not even needed, and claim that the increase in population of the city of Freiburg is fabricated. On that point, however, most statistics disagree with the critics. Multiple sources claim the opposite, including the German Federal Office for Statistics (see calculation from the German government office for statistics from the year 2021 (in German)).

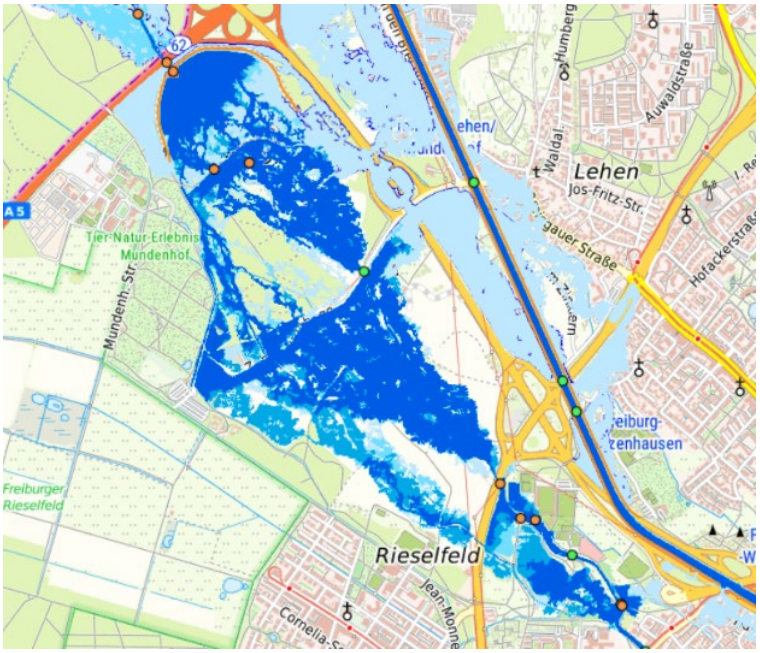

Figure 7: Flooding zone of the "Dietenbach" region (see https://geoportal.freiburg.de/freigis)

The third biggest point is that most of the area planned for development is in a flooding zone of the stream called "Dietenbach" ("Bach" being German for stream or small river). This is true, as evidenced by both an open letter from a hydrologist (see open letter by Prof. Baiker (in German)) and the interactive map of the City of Freiburg.

As seen in figure 9, most of the building area is covered in either a 50 year flood zone (dark blue) or a 100 year flood zone (light blue area). While this is an argument against construction in this area, it is not a wooden construction issue. Regardless of the chosen construction method the flooding zone is always a problem. In the case of the flooding zone the amount of area sealed and the area dedicated to overflow of the river is a lot more impactful.

While some of the criticism is certainly valid, it needs to be considered that there is no real alternative. Contrary to what the critics say the housing is definitely needed as can be seen in every statistic about the growing population of most German cities. The critics also fail to provide a good alternative solution for the housing needs. This only leaves the new development in the Dietenbach area as a solution. To then build it out of wood is probably the best possible solution, in regards to the CO_2 efficiency and climate friendliness in general.

7 A Final Word

Evidently, the amount of wooden construction is increasing even though the sector has been hit by multiple crises. Additionally, the legislation is actively supporting wooden construction efforts by relaxing/simplifying laws and regulations regarding wood construction. Raw material wood is available as supported by import and export statistics where in the last few years Germany even exported wood and still increased the number of wooden constructions.

Climate change and its effects became part of the DNA of any programmes currently launched in the context of environment, forestation, CO_2 net neutral projects, electric cars, new fuels or new mass transportation concepts. Special focus is for sure put on undoing the sins of previous generations to create more resilient forests again that withstand climate change and bark beetle damage.

These surrounding factors have now been understood during this report. The technology featured in the recent innovations of the sector as well.

Today's challenges, however, are not the base factors mentioned above but rather costs and public opinion. Costs are not a wooden construction issue per se. Where proven technology and practices have been used, the wooden construction was usually even cheaper than traditional concrete/bricks. An example can be found in section 5.4. Unique requirements will always make buildings more expensive, whether they are made from wood or with traditional materials. It has to be said, though, that higher investments in the beginning may even lead to a net neutral CO_2 balance which definitely is the most resilient way to take wooden construction into the next decades.

As can be seen in Dietenbach, public opinion can also be a big factor to consider. Interesting to note here is that a lot of the criticism and environmental concerns while not invalid are very unrealistic, as with no alternative being provided it is easy to criticize future housing projects from the comfort zone of your own home.

This showcases the fact that while wood construction in general might even be the construction way of the future especially for the German needs, not everything that glitters is gold.

Wooden construction in general, however, is the cornerstone for the future of sustainable construction.

Glossary

Term	Definition
Schwarzwald	Forest located in the southwest of Germany on the Border to France and Switzerland. Famous for the cuckoo clocks.
Harz	Forest located in the center of Germany, a few kilometers south of Hannover.
Baden-Württemberg	Federal state of Germany located in the southwest. The Schwarzwald is located in this state.
Bayern	Federal state of Germany located in the southeast. Known for its capital city of Munich (München in German). Known English as "Bavaria".
Nordrhein-Westfalen	Federal state of Germany located in the west northwest. Known in English as "Northrhine-Westfalia".
Rheinland-Pfalz	Federal State of Germany located in the west of Germany. Known in English as "Rhineland-Palatinate".

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