Conflicting sociotechnical imaginaries of the future built environment

An analysis of current discourses on timber construction in France and Germany

Building with timber promises many things at the same time: sustainability, economic efficiency, as well as innovative forms and building processes. However, it is disputable to what extent, and under which conditions, timber construction can be considered sustainable. The societal discourse in Germany and France is shaped by four competing visions that favor either 1. a positive CO_2 balance, 2. a particularly time- and cost-efficient construction process, 3. the use of regional resources, or 4. the creation of uniquely designed buildings as the guiding principle of future timber construction.

Hanna Sophie Mast

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Abstract

The construction industry is one of the biggest sources of greenhouse gas emissions. In view of resource scarcity, climate change, and rapid global population growth, the industry faces the urgent challenge of a sustainable transition. The renaissance of timber as a renewable, carbon-neutral construction material could pave the way for more sustainable modes of building. Taking France and Germany as examples, and based on a sociological discourse analysis, this paper reveals four different and conflicting sociotechnical imaginaries of the future built environment. The four imaginaries show specific characteristics depending on the respective national, political, and cultural contexts. Moreover, they include partially incompatible objectives and compete for discursive hegemony, and thus implementation. Scrutinizing the four competing visions and their approach to conflicts and scarcities raises profound questions about their political, technological, ecological, and social implications.

Keywords

construction industry, discourse analysis, discourse coalitions, Germany, France, sociotechnical imaginaries, sustainable transition of industries, timber

Hanna Sophie Mast, MA | Joschka Fischer & Company | Markgrafenstr. 34 | 10117 Berlin | Germany | mast.hannasophie@gmail.com

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In light of the rapid population growth, the United Nations expect the global building stock to double by 2050 (UN 2019). However, already today 36 % of global energy consumption and 39 % of energy- and process-related CO_2 emissions are generated by the construction and buildings sector (GlobalABC 2019). The construction industry thus faces the immense task of creating decent living spaces and attractive jobs for a growing global population while drastically reducing emissions, resource consumption, and waste production.

In the public and political discussion about the environmental impacts of industries, the construction sector has long been overlooked (Braun and Kropp 2021). In recent years, however, wood has been rediscovered as a promising building material, which could pave the way for more sustainable ways of building, since it can avoid greenhouse gas emissions from steel and concrete production and turn buildings into carbon sinks (Churkina et al. 2020). In addition to the increased interest in carbon-neutral construction materials, the hope of creating affordable housing in a more cost- and time-efficient way as well as new technologies for wood processing and automated manufacturing methods also play an important role for the recent *renaissance* of timber construction. Timber experts researching digital design and fabrication methods for timber point out that wood, being lightweight, structural, multifunctional, and receptive to parametrically driven forms enabled by digital design responds to many of the criteria of the "material of the future" (Correa et al. 2019, p. 62). On the other hand, an upscaling of timber construction raises new questions as to the required amount of timber harvest as well as sustainable forest management and possible risks for land use and biodiversity (Mishra et al. 2022).

Considering the urgency for a sustainable transition of the construction industry and the need to take into account the concerns and interests of a wide range of societal actors in this process, this paper examines the current discourse on building with wood in politics and legislation, industry and architecture as well as academia and civil society in France and Germany. These two >

GAIA Masters Student Paper Award

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The *GAIA Masters Student Paper Award*[a] addresses Masters students. They are encouraged to submit their results from research-based courses or Masters theses in the field of transdisciplinary environmental and sustainability science. The winner will be granted a prize of 1,500 euros as well as a free one-year subscription to *GAIA*. The award 2022 was endowed by the by Selbach Environmental Foundation and Dialogik gGmbH.

a For more details see *www.oekom.de/publikationen/zeitschriften/gaia/c-131*.

countries are often referred to as the engine of Europe due to their leading role within the European Union. At the same time, France and Germany are an interesting comparative pair due to their different political cultures. Drawing upon a sociological discourse analysis, this paper identifies the current sociotechnical imaginaries for building with wood and reveals starting points for public negotiation and political action, orientated by the following research questions: Which sociotechnical imaginaries can be identified in the current discourse on the future of timber construction in Germany and France? To what extent is building with wood presented as sustainable? Which coalitions of actors drive the respective visions, based on which values, interests and goals?

After briefly introducing the theoretical background of the analysis, which roots in transition studies and critical discourse analysis, the paper presents the research design and discusses the results of the discourse analysis. The paper concludes with a reflection on the different visions about the future of the built environment and their political, environmental and social implications.

Background and theory

The future of the built environment is a question that is not only of great relevance to architects and civil engineers, but also to environmental and climate scientists, health experts, sociologists, and psychologists. Architecture not only fulfills elementary human needs for shelter and security, it is also the most visible expression of culture and social relations and shapes our everyday practices in a variety of ways (Schäfers 2006, p. 3405). Whereas the built environment is defined as "the human-made space in which people live, work, and recreate on a day-to-day basis" (Roof and Oleru 2008, p. 24), the term also refers to the connection between physical features of space and its social consequences. Buildings influence individual quality of life and health and shape social coexistence, by enabling or hindering encounter and community (Braun and Kropp 2021). Thus, as architectural historian Picon (2006, p. 51) states: "In the case of architecture and construction, as in many other areas of material culture, innovation comes about at the intersection of technical and social issues that need to be decoded". This paper contributes to the task of decoding the current discussions and constellation of interests surrounding timber construction. What lies behind the hope that an age-old building material can solve the problems of the modern construction industry due to its ecological sustainability, regional availability, and technically improved performance? In this regard, what are the concrete expectations, goals, hopes, and fears in politics and industry?

A prominent expectation in the recent literature on timber construction is that technical innovations could pave the way for a whole new architecture and material culture (Correa et al. 2019, Krieg et al. 2015, Bianconi and Filippucci 2019). According to Correa et al. (2019), the re-introduction of the age-old material timber and its new and different uses could catalyze far-reaching changes in the entire construction industry. The new constraints caused by a change in material selection have the potential to spark systemic innovation and even shake up the entire sociotechnical system. Just as developments in steel production and the technically enabled deformability and stress tolerance of reinforced concrete triggered a building revolution in the 20th century, innovations in the area of timber constructions could now stand at the beginning of a systemic transition towards a new building era (Peters 1996, Correa et al. 2019).

Such systemic changes are at the center of research on sustainability transitions (Köhler et al. 2019). One aim of transition research is to conceptualize and explain how radical changes can occur in large-scale industries such as the construction industry. Whilst the scope of this research cannot be explained in depth in this paper, the following analysis focuses on one central aspect of transition processes, which is the role of discourses and collectively shared visions and imaginaries. According to transition researchers, discourses and collective visions of the future fulfill various important functions in the context of systemic transitions: 1. Public discourses about desirable, urgent, or unavoidable lines of development define the realm of what is conceivable and desirable (Konrad and Böhle 2019). 2. They also connect assumptions about problems, goals, and solutions to societal values and scientific-technical approaches to development and influence their chances of implementation and enforcement (Jasanoff 2015). 3. Guiding visions also play an important role in the transition management approach as a central means of mobilizing social actors and the co-ordination of dispersed agency; they mobilize actors from science, industry and politics and thus contribute to the formation of cross-sectoral actor coalitions (Späth and Rohracher 2010, p. 449).

Imaginaries and visions of the future have therefore attracted growing interest in transition research in recent years, as they bundle expectations, make development goals tangible, and orient innovation policy decisions. In social science research, there

is a multitude of terms and concepts for analyzing collective visions of the future. In order to examine the discursive events that constitute the research object of the following analysis, this paper uses a prominent concept from Science and Technology Studies (STS), *sociotechnical imaginaries,* which was developed by Jasanoff and Kim (2009, 2015).

STS are focusing on technology and socio-technical systems or structures and their interdependencies with societies, as well as on the construction of meaning of technical artefacts by social actors and the shaping power of discourses. In this context, Jasanoff and Kim (2015, p. 4) define sociotechnical imaginaries as "collectively held, institutionally stabilised, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology".

Sociotechnical imaginaries are thus collectively shared and discursively articulated ideas about how scientific and technological developments can contribute to social coexistence in the future, especially in competition with the research and development narratives of other states or economic regions (Braun and Kropp 2021, p. 4). Imaginaries contain assumptions about how certain sociotechnical futures could unfold in concrete terms and which technologies, artifacts, infrastructures, actors, legal frameworks, social practices, and patterns of order would be necessary for their implementation.

Interpretative policy research has been observing for some time how collective visions of the future interact with political beliefs and contribute to forging "discourse coalitions" among actors from politics, administration, business, and academia (Hajer 1995). The gathering of actor constellations behind certain visions of the future is by no means neutral or self-evident but interest-driven and strategic and can be impactful for the course of transition processes. The actors who commit their different resources (i. e., material, financial or network) to a given vision are decisive for the opening or closing of certain transformation paths and for their perception as feasible, desirable, or misguided.

Hajer (1995) therefore proposes an approach to discourse analysis, which takes into account this strategic gathering of actor groups behind certain visions of the future. The term "discourse coalition" refers to the interplay of discourses (in this case: sociotechnical imaginaries of the future built environment with timber) and actors who make use of these imaginaries to advance their interests, but who are at the same time influenced and constrained in their ways of acting by the discourse arena (Hajer 1995).

Research design

In order to decode the sociotechnical imaginaries and the respective discourse coalitions in the current discourse about timber construction in France and Germany, 150 political position papers and legislative proposals, statements by industry and architects, as well as publications on timber construction from academia and civil society in France and Germany[1] were analyzed according to the rules of *grounded theory*. An important feature of *grounded theory* is the simultaneity of data collection, analysis, and theory building. This means that the data are not selected in advance by the researcher, but rather in a process of theoretical sampling in the course of the ongoing analysis. For the present analysis, the database was selected over the course of one year and successively expanded, based on a close monitoring of the public and political debate on timber construction in France and Germany, the visit of relevant conferences and several expert interviews. The selected 150 documents were coded with the help of the software *MaxQDA,* also following the rules of *grounded theory*. To disentangle the different argumentation structures and interpretation patterns within a discourse, the researcher and the research object go through three phases of coding: open coding, axial coding, and selective coding. The aim of this process is not only to analytically describe the content of the texts, but to identify and categorize the empirical substance of the discussed phenomenon, including central storylines, concepts, and ideas (Hajer 2008, p. 221). Discourse analysis thus attempts to make statements about a discourse as a whole by aggregating analyses about individual discourse events. Here it becomes clear that discourse analysis is not only theoretically based on an interpretative paradigm but should also be understood as an interpretative research act (Keller 2008, p. 82).

Results: four sociotechnical imaginaries of the future of timber construction

In the analysis, four distinct and conflicting sociotechnical imaginaries were identified. They declare different technologies, processes, and actor constellations as desirable and sustainable and thus suggest specific transformation paths. The results of the analysis also reveal which actors' coalitions promote these respective visions. The following visualization depicts the proximity and distance of the central statements in three of the four discourses to one another (figure 1, p. 154).

The map illustrates that the various potential advantages of timber construction are emphasized to different degrees, depending on the focus of the given sociotechnical imaginary. The groupings of the codes correspond to the central storylines of the four identified imaginaries: The first imaginary of an *eco-balanced timber construction* emphasizes the potential of wood as a renewable resource for climate protection and a circular economy (figure 1, dark blue dots). These two aspects tend to take a back seat in the second imaginary of *serial timber construction*. Instead, this discourse is dominated by the suitability of timber for industrial, digital prefabrication of individual components and the associated time and cost efficiency (figure 1, turquoise dots). The >

1 For a complete list see *www.oekom.de/gaia-supplements*.

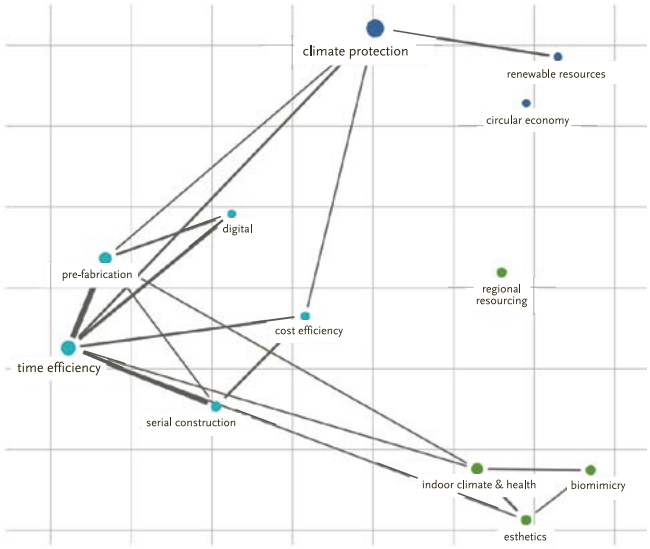

FIGURE 1: Keywords of three main sociotechnical imaginaries for the future of timber construction: *eco-balanced timber construction* (dark blue dots), *serial construction* with low-cost timber building modules (turquoise dots), *frugal timber construction* (green dots) (mapped with the software *MaxQDA*). The dots depict the presence of central keywords (codes) in the studied discourse space. The size of the dots reflects the frequency of their use. The closer the codes are to each other, the more often they were used together in the analyzed material. The thickness of the connecting lines shows how often there were direct overlaps of two keywords.

third vision of *frugal timber construction* aims at regional cycles, sufficiency, and highlights health aspects (figure 1, green dots) whilst the fourth vision of *computer-based co-creation of singular wooden buildings* (which is not displayed in the map, due to the smaller database of only ten documents) aims at a fundamental reorganization of the construction process with the help of digital planning and robotic manufacturing.

All four sociotechnical imaginaries are present in France and Germany and share the idea that timber as a carbon-neutral, renewable building material is a desirable alternative to concrete and steel. Timber construction is expected to contribute to solving the various crises in the construction industry, that is, the productivity, sustainability, and qualification crises as well as the profitability, resource, and confidence crises. However, there is widespread disagreement about the exact nature of the problems, the extent to which wood can contribute to overcoming them, and the priority goals as well as political measures which are to be taken.

1 *Eco-balanced timber construction*

The sociotechnical imaginary of eco-balanced timber construction revolves centrally around the reduction of CO_2 emissions from buildings over their entire life cycle and the consistent integration of building materials and products into a circular economy. The enforcement of a comprehensive ecological assessment of building projects is considered to be the basis for this new mode of building. This discourse is being promoted by governmental and political actors as well as by research institutions and ecologically oriented architects' associations. They call for legal regulations for standardized CO_2 accounting and the establishment of a database with corresponding product information. In Germany, the vision of eco-balanced timber construction is supported by a broad coalition of actors, but the required measures have so far not been laid down, neither strategically nor legislatively. Exceptions are the timber strategies of Baden-Wurttemberg and Berlin, which, however, are not legally binding. The French government, on the other hand, has established strict legal requirements for emission reduction for new buildings and their ecological assessment in its *Environmental Regulation for New Buildings to Protect Against Climate Change*.[2] France is also using the design of the Olympic Village in Paris (2024), built mainly using wood, as an opportunity to position itself as a pioneer in climate-friendly construction. The village with its timber exhibition building, the Grand Palais Ephémère, will be deliberately placed next to the Eiffel Tower, the symbol of the steel revolution and the beginning of industrial construction.

2 *Serial construction with low-cost timber building modules*

In contrast to the ecological focus of the first vision, the sociotechnical imaginary of serial construction with timber modules proclaims above all to meet the needs for affordable housing. This vision promises to overcome the fragmentation of the construction industry, which is being criticized as preindustrial, and its orientation towards individual projects in favor of serial production of standardized, high-quality timber components. The construction industry is expected to catch up in terms of efficiency and productivity and thus save time, materials, and costs. The sociotechnical imaginary of serial construction with timber modules is promoted by industry associations as well as by actors from science and research, even beyond the construction industry. The central problematic of the imaginary is the stagnant productivity of the construction industry which fails to leverage industrial and digital achievements and thereby to solve its efficiency and profitability crises, as well as time and cost constraints and construction errors. To overcome these problems, the principles of industrial mass production are to be applied to the construction sector to provide standardized, prefabricated components or room modules. Computer-aided design (CAD) and manufacturing software and computer-numerically controlled (CNC) machines for the joinery of wood components are still promoted as modern tools, despite their introduction in the 1980s and broader dissemination since the 1990s. In this imaginary, these tools are also intended to prepare timber construction companies for a role of general contractors who take over or purchase services from other specialist lots. Wood is praised as a "high-performance building material" that through new technologies and

2 *Réglementation environnementale des bâtiments neufs:* www.legifrance.gouv.fr/eli/arrete/2021/8/4/LOGL2107359A/jo/texte.

digital planning methods could enable new types of architecture even within tight time schedules and budgets, lends itself to post-densification projects, is associated with positive health effects, and is unquestionably sustainable due to its natural properties. While resource-related or ecological aspects are missing, the cost-effective production of public and residential buildings – especially for sensitive groups such as children, the sick, and the elderly – is emphasized as a social factor.

3 *Frugal timber construction*

While the sociotechnical imaginary of serial timber construction aims at a stronger integration of the construction industry into global supply chains, the sociotechnical imaginary of frugal wood construction advocates strict regionalization of material cycles and minimal use of technology, sufficiency and closeness to nature. The return to artisanal building methods and traditional building materials is central, as well as simplicity and modesty with regard to materials, energy requirements and processes. Frugal timber construction is particularly popular in France and strongly promoted by architects and urban planners. However, traces of this vision can also be found in German industry journals, as well as in projects funded by third-party donors and municipalities. In this imaginary, the problems are seen in the unquestioned belief in the progress of modern societies, which have become disconnected from their natural and social conditions. Relevant documents clearly position themselves against industrialized and automated forms of construction, the use of CO_2-intensive materials such as steel and concrete, or energy-intensive planning and building technologies, and instead advocate low tech approaches. Biomimicry, that is, the imitation of natural processes, the use of wind and sun as thermal or evaporative cooling should help to regulate building temperatures and achieve high energy efficiency with low technology use. Like no other discourse, this sociotechnical imaginary puts social actors at the center of the future built environment. Frugal timber construction stands for a reconciliation with the natural environment, both in an ecological and a social sense: through the renewed appreciation of local resources, regional material cycles, and the revival of traditional carpentry techniques, jobs are to be preserved or created and people are to be involved in the design of their built environment.

4 *Computer-based co-creation of singular wooden buildings*

The fourth sociotechnical imaginary of computer-based co-creation of singular wooden buildings (still) takes place primarily at advanced architectural research institutes that aim at a fundamental reorganization of the building process with the help of digital planning, manufacturing and building technologies. They envision a new kind of material culture characterized by digital, parametric design methods, an innovative approach to materials, new structures of collaboration, and modified manufacturing processes on the construction site and in prefabrica- >

FIGURE 2: The dawn of a new material culture? BUGA Wood Pavilion at the National Horticultural Show 2019 in Heilbronn, Germany. The building was digitally designed and robotically prefabricated by the Institute for Computational Design and Construction (ICD) and the Institute for Building Structures and Structural Design (ITKE) at the University of Stuttgart: *www.itke.uni-stuttgart.de/research/built-projects/buga-wood-pavilion-2019*.

tion (figure 2). At the heart of this vision are keywords such as "iconic" or "non-standard architecture," and "complex geometries". The experimentation with materials – first and foremost timber – based on digital, parametric design, robotic fabrication, and automated construction technologies is central to this vision. However, the sociotechnical imaginary 4 counters the one of serial timber construction, which also claims to use digital technologies to modernize construction and relies on industrially standardized prefabrication: according to imaginary 4, the full potential of digital technologies for timber construction does not lie in standardization, but in the computer-based planning and production of individual, unique components and buildings. Here, too, nature is a role model, according to Achim Menges, one of the architects of the BUGA Wood Pavilion (figure 2): "Compared to technical constructions, natural structures in the animal and plant world usually have much more complex forms on numerous hierarchical levels. This 'more' in form is often the reason for their special performance and material efficiency and goes hand in hand with a 'less' in material use and resource consumption" (Krieg et al. 2015, p. 22).

Reflection: conflicting visions of the built future

The construction industry faces the challenge of having to adapt urgently to the changing conditions caused by resource scarcity, climate change, globalization, and digitalization. A business-as-usual scenario seems unlikely as the demand for a fundamental change in construction speaks from all the analyzed documents. Wood as a versatile building material is expected to enable the necessary climate adaptation, the provision of affordable housing and a fundamental restructuring of the European construction industry.

However, the analysis of the current discourses on timber construction shows that very different sociotechnical imaginaries of timber construction with partially incompatible objectives compete for implementation. In the view of the urgency of the ongoing climate and resource crisis the question whether the ultimate guiding principle of future timber construction should either be a positive CO_2 balance, or a particularly time- and cost-efficient construction process, or the use of regional resources, or the creation of unique, parametrically designed buildings, is highly political. At the heart of the debate lies the question, to what extent and under which conditions timber construction can be considered as sustainable. This question remains difficult to answer since all four sociotechnical imaginaries claim sustainability for themselves – while referring to very different priorities and values. To enable reliable and effective standard setting – as demanded by all the analyzed discourse coalitions – more research on the political, technological, ecological, and social implications of an upscaling of timber construction is needed.

Moreover, the promised transformation of the current building system to a more efficient and climate-friendly one, which ought to be anchored in new modes of timber construction is hardly institutionalized, and far-reaching innovations are so far only pursued in academic research. The comparison of France and Germany reveals a somewhat more daring consolidation of ecological claims in France, and a somewhat stronger market orientation in Germany. Thus, the public debate on architecture as the most visible expression of culture and social conditions shows that the handling of resources, risks and social needs also depends on political culture and the design of state institutions. For example, France as a centralized state puts forward strong legislation, which favors timber construction, while the German federal states pursue different strategies. On both sides of the Rhine, however, the paths to the future built environment are still to be negotiated and could be subject to further research.

One of the main sore points the future built environment with timber is the question of the sufficient availability of wood, which has not been conclusively resolved. The worrying state of European forests (Forzieri et al. 2021) and global competition for the raw material hover like a sword of Damocles above all four sociotechnical imaginaries of the future of timber construction. As Mishra et al. (2022) point out, the effects of climate change, notably wildfires, insect outbreaks and drought make any tree-planting schemes an uncertain bet. Moreover, large timber plantations do not come without impact on land use and could further increase the loss of biodiversity as well as the pressure for deforestation. Thus, to prevent the transition to a timber-based building system from coming at the expense of pristine forests and biodiversity, effective regulation and careful planning is necessary.

Scrutinizing the competing sociotechnical imaginaries of the future built environment and their handling of conflicts, trade-offs and scarcities raises profound questions about the paths to the built environment of tomorrow, as well as about their political, technological, ecological and social implications. It is worth paying attention to these developments today and engaging in the debates about shaping the built environment of tomorrow.

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Hanna Sophie Mast
Franco-German double Masters degree in political science and sociology from the University of Stuttgart, Germany, and Sciences Po Bordeaux, France. Specialization in regional sustainable development strategies at the University of Guadalajara, Mexico. Currently public affairs and sustainability consultant at Joschka Fischer & Company, Berlin, Germany, and freelance moderator. Research interests: sustainable transition of industries.