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Green Energy and Technology

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# Foreword

The Ethics of Wood—It is certain that wood will remain one of the leading construction materials in the future due to its aesthetic, structural, and environmental characteristics. Many of our most deeply rooted understandings of the world and architecture are based on the use of wood. Some historians interpret the proportions of the Greek Doric style, which defined the aesthetic canons of western civilization, as based on the proportions of trees. However, the relationship with wood and trees extends deeper into the backdrop of our cultural subconscious. As Juhani Pallasmaa once remarked, the tree is one of mankind's most common and meaningful symbols—consider, for example, the Tree of Life, the Sacred Tree, the Tree of Fertility, the Tree of Knowledge, and the Sacrificial Tree. All of these different associations are hidden in the shape and meaning of a tree and are still reflected today in our relation with wood. All of these mythic dimensions aside, compared to brick, glass, and steel, wood is still one of the most accessible materials. Throughout the centuries, it was used and installed in ways that showed respect for its natural qualities—until the end of the nineteenth century, which saw the development of new machinery for sawing and grinding wood. Frank Lloyd Wright characterized these as tools wielded by "butchers" that lacked an understanding of the nature of the material and produced great waste.

The growing use of this renewable resource is sustainable because the growth of European forest resources exceeds consumption. The increased use of wood is creating new opportunities for innovation in construction and architecture. Wood has been experiencing a renaissance as a construction material. In the past decade, innovative wood construction systems have resulted in a rebirth in the ecological, construction, architectural, and economic sense. Their excellent ecological characteristics, fast and simple construction, and the friendly living environment that these systems create make them a legitimate alternative to concrete, steel, and masonry construction.

Wood is a warm, fragrant material. It tells a story. This organic material has a complete life cycle: from growth in the forest, to raw materials, and finally to

decomposing biomass or fuel. In addition to being ecologically economical, wood is easy on the senses. In the artificial world of today's urban environment, the use of wood ensures a sense of connection with nature. However, its use requires a good understanding of all its characteristics; as a result, a well-designed wooden building still presents a challenge for architects. We can smell, hear, touch, and see natural wood. With modern chemical or physical processing, wood loses many of these properties. This convinced Aalto that natural wood will always remain a precious material in architecture.

Today the use of wood in architecture is becoming fashionable. It has been used all too often and uncritically, constantly incorporated everywhere merely as a cult material, as a brand label that ensures better market success for the product. Even the auto industry increases the value of a vehicle by a few percents if the interior elements are made of wood or even imitation wood. A similar development can be seen in the facades of modern structures, where imitation wood is increasingly being used. In contrast, large urban squares are being covered with precious wood under the pretense of sensitivity to the environment, causing utterly uncritical destruction to endangered tropical forests. Just as it is inappropriate to wear a leopard-skin coat today, because it is not only tasteless but above all immoral, increased moderation will be necessary in the use of tropical wood.

This publication is a step toward creating an honest relation to the use of wood. It features the valuable experience of modern architects and technical experts blazing the path into the future development of the use of wood as one of the most important materials and building blocks of our urban future.

Prof. Mag. Peter Gabrijelčič, dean
University of Ljubljana, Faculty of Architecture, Slovenia

The book gives a comprehensive overview of the fundamental aspects of the usage of wood in sustainable, carbon efficient architecture. Especially the interesting and exhaustively investigated chapter on building materials provides useful information about resources, properties of products and markets and shows a good summary of current and future trends in research and development. This selection of case studies demonstrates an informative cross-section of Slovenian timber architecture and the substantial progress made in recent years. However, it indicates as well that there is still room for further improvements that this book in discussion certainly will help to obtain.

Dr. Franz Dolezal
Holzforschung Austria, Vienna, Austria

Slovenia might be seen as the very center of the Adriatic-Alpine Region and Slovenian architecture might also be somewhere in between the mediterranian and alpine influence. This book on the Slovenian timber architecture is an excellent

reflection on the current European and regional developments in the increased use of wood as a sustainable building material for the future. It comprises an insight to wood as a sustainable material and its use in modern architecture. It is also a best practice example on how to shape the future with timber in construction in this region. Valuable information on wood and wood-based panels as a building material and about the Slovenian wood industry are an additional asset of the book.

Prof. Dr. Dr.h.c. Alfred Teischinger
University of Natural Resources and Life Science
BOKU Vienna and Competence Centre for Wood Composites
and Wood Chemistry (Wood K plus), Vienna, Austria

Wood, a traditional material with a broad knowledge base that has developed over centuries, enters the third millennium with some strong reasons to replace competing construction materials.

This book is focused on Slovenian timber architecture; however, the Slovenian case is presented in relation to European and global trends in the field of sustainable construction and the role of buildings in sustainable development. The authors introduce the content with the topic of green buildings movements, the current trends of creating living environments, Slovenian forests and wood species, and describe European and Slovenian legislation directly and indirectly affecting contemporary timber architecture. They continue with the sustainability with respect to building materials with presentation of wood and wood-based composites produced and used in Slovenian timber architecture together with their environmental impacts. Furthermore, a selection of sustainable buildings in Slovenia is presented. The timber construction systems, green building rating systems, environmental impacts, and durability of timber housing are discussed. The book concludes with case studies of Slovenian contemporary timber architecture, residential and non-residential timber construction.

I strongly believe that the monograph is useful to architects and future experts for planning optimal timber buildings and highlights the main benefits of using timber for construction. Furthermore, I hope that the book will encourage collaboration among different sectors as well as universities, research institutions, trade associations, and number of advanced wood-processing companies leading to knowledge integration and new trends in timber architecture in Slovenia and worldwide.

Prof. Dr. Parviz Navi
Bern University of Applied Sciences, Biel-Bienne, Switzerland

The book on "Contemporary Slovenian Timber Architecture for sustainability" demonstrates expert knowledge and affection for a unique material that modernises our way of living healthier and durable. Innovative design and architecture has always been a tradition in Slovenia. Readers of this book will discover the dawning

of the wooden era in a country that is covered by more than 60 % of rich and diverse forests, which feed the imagination of designers, architectures and builders.

Dr. Andreas Kleinschmit von Lengefeld
Director of Innovation Research
Technical Center for Forests, Wood Products and Furniture
(Insitut Technologique FCBA), France

Although this book has a Slovenia focus, the broader issue of timber in sustainable construction really comes through, making it appealing to a wide audience. The detailed and well-researched aspects on the forest resource, wood-based products and their sustainability and sustainable buildings will be particularly suitable for students of architecture, who may have little prior experience of wood as a material. The case studies add value, showing how theory can be put into practice.

Prof. Dr. Mark Hughes
Aalto University, Espoo, Finland

Enhanced and sustainable use of timber in contemporary and urban architecture is increasingly focused on in Europe and in North America. This monograph adds valuable and important information on sustainable material selection and timber architecture—and at the same time it brings forward the many possibilities in timber design as well as showing the beauty and a passion for wood. Read it and get inspired!

Dr. Lone Ross Gobakken
Norwegian Forest and Landscape Institute, Norway

Today's society is highly critical. Consumers place a strong emphasis on performance as well as looks—there is a feelgood factor in having something that is pleasing to the eye. Thus, building materials must achieve desired service lives as well as maintain their aesthetical appearance. However, there is an increasing trend for products to be sustainable and of sound environmental credentials. People are beginning to recognise that resources are finite, and where possible products should be manufactured from more sustainable supplied. The only materials that readily fall into the category of sustainable are biobased building materials.

Biobased building materials covers a wide scope—from solid timber to straw bale to sheep's wool insulation. Through efficient manufacture, biobased materials can provide many of the building components in modern society. Also there is the added benefit that the "natural" look of these materials are viewed as aesthetically pleasing. However, biobased materials cannot rest on their laurels. It is necessary to continually improve design and uses of these materials to ensure that.

Indeed, maintaining and expanding the market potential for bio-based building products in indoor and outdoor construction uses remains a key activity for European industry in the forestry and biotechnological sector. Performance data for many environmental friendly building materials, especially in new uses, are often lacking as well as suitable comprehensive test methodologies to determine their resistance against mould, stain, and decay. Similarly these new uses need to be evaluated in terms of decay hazard, resulting response on climatic loads and thus performance of different bio-based building materials. To do this requires networking and scientific exchange between different disciplines, such as material sciences, wood technology, biology, biotechnology, building physics and engineering. Consumer demands and preferences, which might serve as limit states to develop service life prediction and performance models, will consider aesthetical aspects as well as the functionality of building assemblies. Resolving these issues will provide considerable benefit to a pan-European low carbon building agenda.

This book considers the use of wood in architecture in Slovenia, but represents key developments that are ongoing across Europe, as demonstrated by the activities of COST (Cooperation in Science and Technology), where many of the above activities are considered in the Action FP1303 ("Performance of Biobased Building Materials"). Through the coordinated activities of this action, individual work such as this book, can be brought together to provide a lasting benefit for Europe and its people in the first instance, and potentially globally.

Dr. Dennis Jones
Chair, COST FP1303, SP Technical Research Institute of Sweden, Sweden

Slovenia and Sweden have many similarities in terms of the importance of forests for their society, and not least both countries have a long tradition of sustainable forestry and the industrial refining of the raw material which forestry can provide. Nowadays, the forest and forest products form one of the most important basis for the transfer to a biobased economy in several European countries. The way we live is changing and we become much more aware of how much energy we use, how much carbon dioxide we generate, how much waste we produce, how production influence the environment, and so on. Environmental advantages of using wood as a material can also be an important sales argument on the market, as environmental issues are becoming increasingly important. For example, the construction industries achieve lower greenhouse gas emissions when wood is used as a building material than with other traditional building materials such as concrete and steel. Whenever wood is used for housing, the carbon in the wood is bound into the building material over a long period, and several studies conclude that wood as a building material leads to lower carbon dioxide emissions.

The intention to gather together in one book the key elements of sustainable use of wood in buildings is an exemplary initiative. This work is of wide applicability for researchers, professionals of timber construction, as well as students studying

the science of materials, wood technology and processing, civil engineering, and architecture.

My belief is that this book will be of great use and will have some impact on the future of a sustainable forest products industry.

Prof. Dr. Dick Sandberg
Luleå University of Technology, Skellefteå, Sweden

Slovenia may be one of central Europe's smaller countries, but its forest resource is large in proportion and the commitment shown there in recent years by its architects to deliver new buildings that make exemplary use of indigenous timber products is a model that many larger countries could well learn from. This book not only analyses the constraints that currently mitigate against local use of the only genuinely renewable construction material we have, but places it at the forefront of debate about how a truly sustainable built environment might be achieved. The case set out here by the authors is rigorous, comprehensive, and compelling: governments in every country in Europe should aspire to have a similar in-depth analysis produced about of their own forest and timber resource and the low carbon, low energy opportunities that might be unleashed in their respective economies were they to prioritise its use in construction.

Peter Wilson, architect, author, and director
Wood Studio research center within Edinburgh Napier University's Institute for Sustainable Construction, Edinburgh, UK

Human society faces one of its greatest challenges due to climate change driven by anthropogenic emissions of greenhouse gases. Despite widespread publicity, global levels of carbon dioxide continue to increase. One very effective strategy of dealing with this serious problem is the use of timber in construction. The growth of trees in sustainably managed forests involves the sequestration of atmospheric carbon dioxide in the above ground biomass of the trees. When this timber is harvested and used in the construction of buildings, the sequestered carbon can be stored for long periods of time. Further benefits arise because timber products invariably have lower embodied energies associated with them compared to non-sustainable and non-renewable alternative materials. In this monograph, the underlying principles of the use of timber as a sustainable building material are reviewed along with the role of buildings in a sustainable society. The monograph goes on to give numerous well-described case studies of sustainable timber buildings in Slovenia. The monograph contains numerous references, is well-written and nicely illustrated. The examples given are inspirational. Slovenia has much to teach the world about sustainable architecture.

Prof. Dr. Callum Hill
JCH Industrial Ecology Limited, UK

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The monograph "Contemporary Slovenian Timber Architecture for Sustainability" by Kuzman and Kutnar is a comprehensive overview of modern timber architecture and sustainability of the built environment. The monograph is wonderfully illustrated with over 40 case studies of commercial and public buildings, as well as residential structures. Although the monograph was written with the perspective of the contemporary Slovenian building market, I found the information to be widely applicable throughout Europe as well as other regions of the world. The chapter on sustainable buildings provides an excellent summary of green building rating systems used in Europe and North America. Not to be overlooked, this monograph contains an impressive list of literature citations that is valuable resource to experts and newcomers to contemporary timber architecture.

Prof. Dr. Frederick A. Kamke
Professor and Co-Director, Green Building Materials Laboratory
Oregon State University, Corvallis, Oregon USA

The authors state a rather modest goal for this book, describing the Slovenia's trends in sustainable management and the role of timber architecture for sustainability. They achieve this goal very well, due to describe the traditional wood construction, but also introduce the new thinking approach to improve the connection between natural environments and the energy-efficiency in the constructions. This book represent an interdisciplinary integration of forestry, architecture, and human well-being aspects. Such integration is crucial to reach the equilibrium between human needs and sustainable uses of forests around the world.

Dr. Guillermo Martínez Pastur
CADIC CONICET, Ushuaia, Tierra del Fuego, Argentina

A way to Sustainable Architecture by new technologies for engineered timber structures: Only the use of wood in the construction field can save and renew the forests of the world and motivate people to maintain and plant forests in a sustainable way.

Prof. hon. Julius Natterer
EPFL, Swiss Federal Institute of Technology Lausanne (www.nattererbcn.com)
Switzerland

*Wood in Architecture from Prehistoric Times to Present Day*—Wood is the premier material in architecture. Since the dawn of time, wood use has directed the art of building, and its use in construction has shaped other construction systems. Its role is thus closely intertwined with the history of humankind.

Full understanding of this versatile material requires keen attentiveness and strict discipline; its use throughout history has resulted in incredibly diverse implementations worldwide.

Adaptable to different geographical conditions, which is reflected in its respect for local architecture styles and their evolution, wood can be used in all types of structures: from cottages to palaces, from street furniture to the most impressive bridges.

Wood use has created an architectural expression that is based on age-old traditions. Its adaptability is seen in its versatile use throughout the world, including in combination with other construction materials such as rock, brick, mud, concrete, and metal.

Its use as scaffolding allowed for the construction of castles, cathedrals, bridges, and other grand structures such as the Eiffel Tower and the Garabit Viaduct.

Since the nineteenth century, new techniques have been developed to meet the needs of the modern society. This traditional material has been used to create spaces that allow for different levels of understanding, relations, and rhythms in the modern dialog between man and architecture.

Prof. hon. Roland Schweitzer
Architecte Urbaniste—HFAIA, Paris, France

The book highlights the Slovenian contribution to sustainable timber constructions in an impressive and comprehensive way. A profound analysis of the environmental impact when using natural resources paired with the documentation of numerous realized objects all over the country cover the whole bandwidth of this topic. Therefore, it is a must have not only for relevant libraries, but also for architects, engineers, designers, students, and everybody else who is involved or interested in this field.

Robert Widmann, research engineer
EMPA, Swiss Federal Laboratories for Materials Science and Technology
Duebendorf, Switzerland

The book "Contemporary Slovenian Timber Architecture for Sustainability" by Manja Kitek Kuzman, Andreja Kutnar—is a book that presents a contemporary and up-to-date review of all architectural developments in Slovenian timber architecture in the context of sustainability. Current trends toward a more sustainable way of working, living, designing and building make the theme of this book—timber architecture and its role in sustainable construction and development very topical globally.

Furthermore, this is a book relevant not only as a thorough recording of Slovenian contemporary timber architecture, but beyond that—the writing puts Slovenian timber architecture in context and relation to European/global trends.

The beautifully presented text and illustrated case studies invite a broad audience to the book. It is a "must read" for anyone interested in the field—Timber architecture!

Prof. Dr. Olga Popovic Larsen
The Royal Danish Academy of Fine Arts Schools of Architecture
Design and Conservation School of Architecture
Institute of Technology Phillip de Langes, Copenhagen, Denmark

The importance of sustainability as a process of the global consensus for surviving is recognized in this book. The importance of sustainability through wooden architecture is corroborated with additional reference to and explanation of Slovenian and European Union building legislation. Every book chapter has separated Slovenian and international references that makes the book closer to readers.

The fourth part of the book consists over 50 excellently presented selected case studies that are very impressive. Divided in two functional groups: Individual and Residential Areas and Public Objects, examples are presented with plans, photographs and short textual description.

Every case study is described in short with the range of energy efficiency (low energy, passive, etc.) that is an especially important sustainable characteristic. This selection speaks more than topically pointed terms as material, legislation, energy efficiency and sustainability. It speaks and shows a lot about the high level of wooden architectural quality attained.

Prof. Dr. Ljubomir Miščević
University of Zagreb, Faculty of Architecture, Croatia

The book written by M. Kitek Kuzman and A. Kutnar covers the whole value added chain beginning with the Slovenian forestry industry up to final building architecture. With a special focus on innovative developments, the chapter 'Building Materials and Sustainability' contains the description of all products relevant in timber engineering. The following section 'Sustainable Buildings' shows how these products mentioned are used for different timber building systems. The last chapter 'Timber Architecture—Case Studies' finally presents an impressive performance showcase of Slovenian timber architecture.

Univ.-Prof. DI Dr.techn. Gerhard Schickhofer
Technische Universität Graz
Institut für Holzbau und Holztechnologie, Austria

"Contemporary Slovenian Timber Architecture for Sustainability" by Manja Kitek Kuzman and Andreja Kutnar is a comprehensive, well-researched compendium of wood products and wood construction best practices in Slovenia. The monograph provides a sound description of the current EU and Slovenian policy

and regulatory framework including applicable codes and standards, subsidies and incentives as well as voluntary certification systems, as context for a detailed description of the Slovenian forest and wood products industry. The monograph provides a detailed description of the technical, economic, environmental impact and indoor environmental quality attributes of wood products used in the Slovenian building industry, from dimensional lumber to wood composites, including added-value engineered products. It also sets the context for a series of informative case studies of Slovenian wood construction by providing a description of EU and Slovenian green building construction practices, European directives and applicable Slovenian policies and regulations including existing green building rating systems and those currently being used in Slovenia. The case studies in the monograph are compelling, replicable examples of iconic Slovenian buildings that have embraced wood construction and its implicit social, economic and environmental benefits.

Alberto Cayuela, P.Eng., PMP, LEED AP
Director, Operations and Business Development
Center for Interactive Research on Sustainability
University of British Columbia, Vancouver, Canada

The prominent and self-evident application of wood in contemporary architecture is one of the best proofs of a radically changed perception towards a material which long time was associated with attributes as antique, old fashioned, conventional. Today, one of the earth's oldest building materials is highly esteemed as a multifunctional renewable resource which can make decisive contributions to support sustainable development of mankind. What are the reasons for this promising renaissance of wood, especially in building and architecture? The key answers are given in this monograph authored by two female scientists who pooled their competences in material technology, building design, and related environmental aspects. Focusing on Slovenia as the country of their origin, they illustrate that wood, when processed and used intelligently, ideally fulfils the requirements of a sustainable building material, due to its biological origin, renewability in natural forest systems, carbon sink effects, low energy consumption, good thermal insulation properties, and recyclability. Wood-based products and timber construction systems can meet high standards in technical, environmental, and esthetical quality, criteria which are appreciated by modern and responsible architects aiming to contribute by their projects to sustainable development. Examples of recently built timber-based architecture (individual residential and public objects) depict the high variety and design standard of timber architecture in the Alpine-Adriatic region, and the accompanying characteristics resume the technical performance values which underline the high efficiency of the constructions in heat insulation and construction time.

This well-presented monograph will give incitement to architects, building-owners, construction industry experts and students to delve into the details of timber products and timber construction systems, and to contribute to the future development of contemporary and sustainable timber architecture.

Prof. Dr. Klaus Richter
Chair of Wood Science
Technische Universität München
Munich, Germany

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