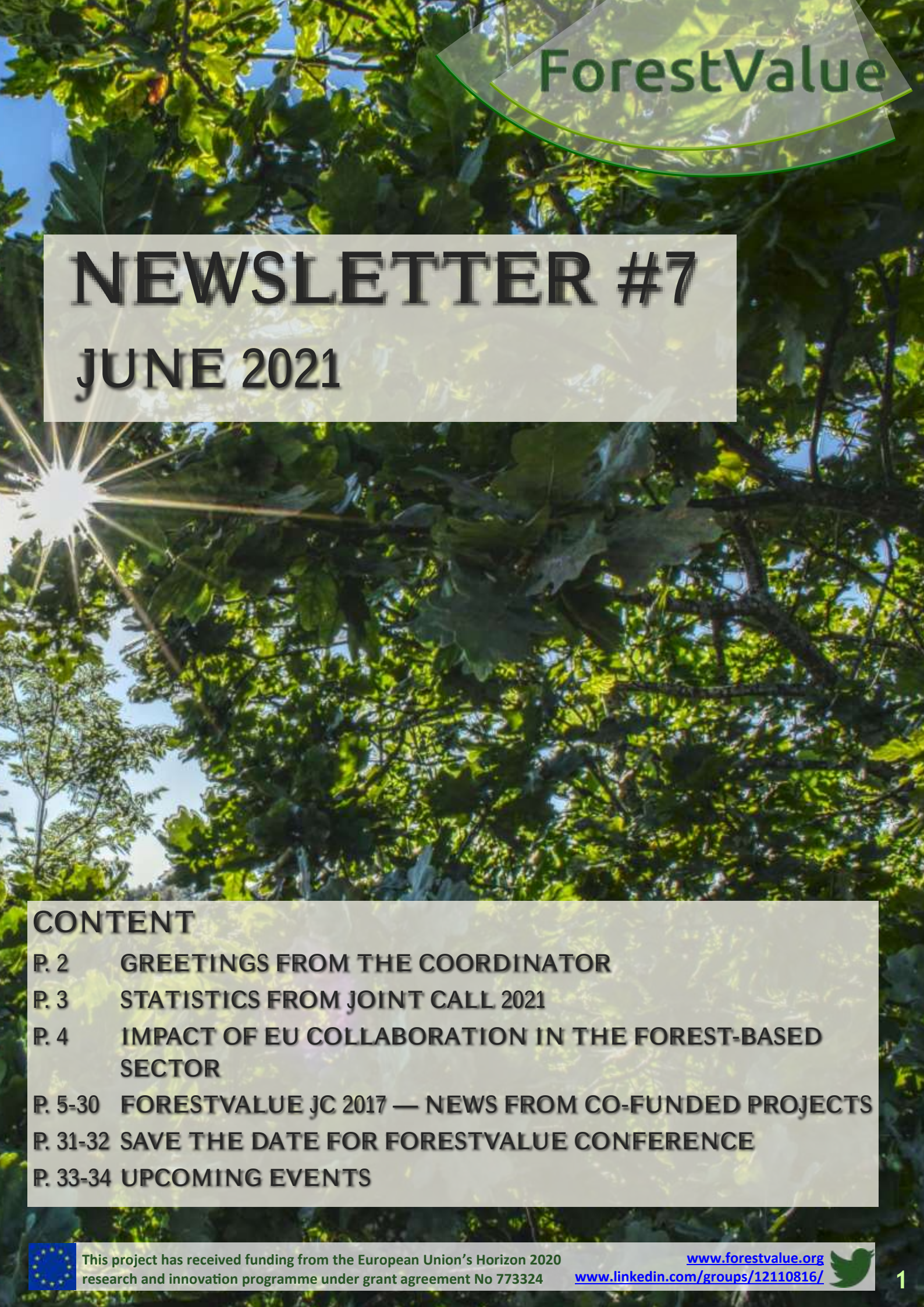

ForestValue

# NEWSLETTER #7

## JUNE 2021

CONTENT




This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 773324


www.forestvalue.org
www.linkedin.com/groups/12110816/

# Dear ForestValue Friends,

on the 19th of Jan 2021 we launched the ForestValue Joint Call for Research Proposals in 2021 with an indicative total public funding budget of over 11 million € from 15 funders in 10 countries. Besides the funding agencies listed in the Call Text, we were happy to welcome two Estonian funders to join the call as additional funding partners: Estonian Ministry of the Environment and Estonian Research Council.

As written in the Call Text, the overarching aim of this joint transnational call is to support projects that will produce knowledge to promote the best possible use of forests and forest resources for the benefit of society on its way to a climate-neutral circular economy and sustainable society.

By now the call is closed (13 April 2021) and all proposals are now subject to confidential evaluation as described in the Call Text. The first proposal assessment phase – the formal eligibility check performed by the Call Office – is already finished and from a total number of 60 submitted proposals 47 passed this phase. For further information and statistics, see a separate article later in this issue.

As we all are experiencing, the pandemic is still causing problems in many ways, and this is also the case for any transnational project. In April we run a survey among the 17 projects running under our previous Joint Call (JC2017) and the outcome is clear: 15/17 projects have been hit by different regional/national restrictions so hard that the funders need to start preparing for project extensions. This work is now ongoing and we have also initiated discussions with the European Commission to extend the ForestValue Grant Agreement accordingly, more information will follow soon.

Finally, I would like to highlight that Horizon Europe, the new ambitious European Framework Programme on Research and Innovation for the period of 2021 to 2027 was launched in the beginning of February, and for example the Work Programme of 2021-22 of Cluster 6 '*Food, Bioeconomy, Natural Resources, Agriculture and Environment*' has been published now in June. This opens a number of new possibilities for transnational collaboration to all of us, so it is certainly worth checking the published Work Programmes and any related news.

For your information, among other things the above WP includes a topic titled '*Strengthening the European forest-based research and innovation ecosystem*', and if your recall our efforts back in 2019 for a European Partnership for our sector (see my greetings in ForestValue Newsletter #4), this is now to further support those joint efforts. In a smaller team led by the Ministry of Agriculture and Forestry of Finland (MMM) and the European Forest Institute (EFI) we have already started working on this, so we'll let you know of these efforts in more details soon.

Furthermore, the new European Partnerships will be an interesting new instrument to follow. For example, the European Partnership on biodiversity is expected to start late 2021 and they have already announced that the first one of their Flagship Programmes - PROTECTION' (Supporting biodiversity and ecosystem protection across land and sea) - will get started with a call for proposals to be launched already during their first year. This will certainly be relevant for forest sector, too, so let us keep our eyes open for this.

Wishing you all the best, at least the future is looking a bit brighter not least thanks to the vast amount of sunlight also here up in the north but when the number of people getting their first and second doses of the COVID-19 vaccine is growing daily, too, and as a result, lockdowns are gradually lifting and restrictions are easing. Hope to see you (in person) soon!

Have a nice summer and still, stay safe,
Mika

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# STATISTICS FROM JOINT CALL 2021

The second call for joint European research projects under the ForestValue Research Programme has an indicative total public funding budget of over € 11 M. Projects are supposed to start late 2021/early 2022. The call for proposals opened on 19 January 2021 and was closed on 13 April.

The overarching aim of this joint transnational call is to support projects that will produce knowledge to promote the best possible use of forests and forest resources for the benefit of society on its way to a climate-neutral circular economy and sustainable society. The participating funders (15 funders from 10 countries) have decided that the call will address the whole forest-based value chain in the following three areas:

1. Sustainable and multifunctional use and management of forests, to maximize their contribution to all SDGs
2. Building with wood from various perspectives
3. Analysis of benefits, synergies and trade-offs in the use of forest biomass

Sixty proposals were submitted to the ForestValue Call for joint European research projects. In total 47 of the submitted proposals passed the first proposal assessment phase, the formal eligibility check performed by the Call Office.

The formally correct 47 proposals have a total requested funding of ca. € 50 M with a total own contribution of ca. € 9 M and over € 1 M cofunding from other sources. 51% of these proposals focus on Topic 1 „Sustainable and multifunctional use and management of forests“ 40% aim to support Topic 2 „Building with wood“, and 9% focus on Topic 3 „Analysis of benefits, synergies and trade-offs in the use of forest biomass“. Besides partners from the 10 participating countries in the call, also some third countries are involved in the consortia: Estonia, Austria, Czech Republic, UK and Spain.

Currently, the 47 proposals are checked for their eligibility by the participating funding agencies in line with the restrictions laid down in the Specific National Rules in Annex IV to the Call Text. The proposals which will eventually pass the national eligibility check will then be scientifically evaluated by the International Expert Panel with regard to the criteria laid down in Annex I to the Call Text. At the end of the evaluation process, the International Expert Panel will determine on one final ranking list of proposals and based on the ranking list and the available national funding, the funding organisations will decide on the projects to be funded. The applicants will receive the assessment results at the end of September 2021.

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# IMPACT OF EU COLLABORATION IN THE FOREST-BASED SECTOR

In order to evaluate the "*Impact of EU collaboration in the forest-baed sector*" ForestValue implemented a brief online survey among the transnational RDI projects funded by the ERA-Nets WoodWisdom-Net+ (2014-2017), FORESTERRA (2014-2017) and Sumforest (2017-2020). The survey was sent out to 32 projects and received answers by 18 projects. The projects funded via ForestValue will answer the survey once they finish their projects. A summary of the major outcomes can be found below:

- Over 60% of the respondents participated in an ERA-NET project for the first time.
- **BETTER RESEARCH:** Projects indicated a much more extensive exchange of knowledge and some even mentioned that the frame of an ERA-NET project gave their research activities more attention and reputation.
- Unfortunately no marketable product or service was derived DURING the project period but in some cases after the project had ended. **66% of the respondents indicated that their project results, deliverables and techniques are STILL in practice and are used in other approaches.** A few examples:


* ***PLAFCO,*** *a plastic replacement for disposable products such as straws, cutlery, plates and packaging material, which can also be used for plastic-free packaging. (Originated from project COMPAC)* [www.plafco.fi](http://www.plafco.fi)
* ***SleeperProtect,*** *an innovative treatment applied to all kind of wood-based sleepers. A long lasting wood protection. (Originated from project CreoSub)* [www.fuerstenberg-thp.de/en/products/](http://www.fuerstenberg-thp.de/en/products/)
* ***Tanasote****, an innovative oil-based treatment developed by Lonza, providing effective long-term protection for high-performance wood applications such as masts, railway sleepers and agricultural wood as an alternative to traditional creosote-based treatments. (Originated from project CreoSub)* [www.lonzawoodprotection.com/eu/tanasote/](http://www.lonzawoodprotection.com/eu/tanasote/)
* *The project REFORCE established new tools such as the web interface to remote-sensing time series for forest greenness dynamics.*
* *Other project results were implemented in forest models and management guidelines.*

- **BRINGING PEOPLE TOGETHER:** Overall, 16 out of 18 projects expressed that their ERA-Net participation has opened up new cooperation/ collaborations, networks and partnerships. Furthermore, the cooperation between timber construction sectors and designers of timber buildings, timber structural engineers and cross-border cooperation in general was strengthened. The ERA-NET participation led in many projects to increased PhD positions and the doctoral candidates found job positions faster. Nine projects exchanged scientists. It was highlighted that networking and the exchange of scientists from different parts of Europe was simple and straightforward in the frame of an ERA-NET project.

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# UNDERSTANDING SMALL-SCALE FOREST OWNERS AND THE CONSEQUENCES OF THEIR FOREST MANAGEMENT DECISIONS

The aim of the project ValoFor is to understand the contribution of small-scale forest owners to the development towards a bioeconomy. As small-scale forest owners encompass 99% of all European forest owners and manage around 60% of Europe's forests, they play an important role in this development but might encounter increasing challenges. To investigate drivers influencing small-scale forest owners, the participating project partners in five European countries, i.e. Austria, Finland, Germany, Slovenia and Sweden, approached the task from different points of view to support decision making on forest and policy level.

Last year a survey and a choice experiment were carried out, where in total around 2500 small-scale forest owners from the five participating countries responded. Besides information about the forest owner, such as age, gender and education, and about their forest, such as size of the forest property and background of landownership; we collected data on forest owners values regarding their forest, how they currently manage it, if they plan to change the management and if monetary compensation could lead to such a change. Four potential management scenarios were defined: "*No management", "Close to nature", "Business as usual" and "Increasing profitability*". The results of the survey showed differences between the countries. For example, while forest owners from Austria, Germany and Slovenia found environmental values of their forests to be most important, social values were of highest importance in Finland and Sweden (Figure 1). Also the current management activities and the willingness to change them varied between the countries.

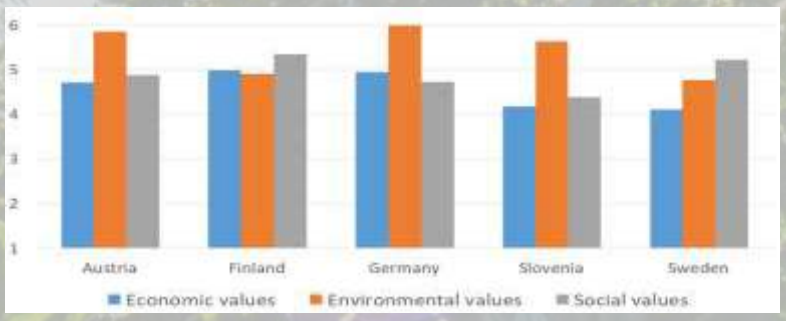


**Figure 1:** *Importance of forest values for small-scale forest owners. . 1 = "not important at all" to 7 = "very important". (Kerstin Westin)*

To further understand which national and European subsidy or incentive systems could potentially impact forest owner's decisions, we compared the subsidies focused on forests from the five countries. This comparison revealed large differences in how subsidies are distributed: on the one hand between forest owners with different holding sizes and on the other hand between various subsidized measures. It became apparent that countries have different "overarching goals" and adapt their system to their needs, what leads to a broad range of subsidized measures.

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(2 of 2)

ValoFor
ForestValue

# UNDERSTANDING SMALL-SCALE FOREST OWNERS AND THE CONSEQUENCES OF THEIR FOREST MANAGEMENT DECISIONS

The four defined forest management scenarios were also used to simulate the forest development in the five countries under different climate change scenarios until the year 2100. The simulations were based on national forest inventory data with forest growth models of the respective country (Austria & Slovenia: CALDIS, Germany: WEHAM, Finland: MELA, Sweden: Heureka). We used the output of these models to calculate not only future biomass and yield, but also other forest ecosystem services like deadwood or biodiversity (Figure 2).

Information calculated from the forest development models is now used for an economic analysis to understand the potential of small-scale forest owners on the timber market (national and European) and a multi-criteria analysis to find potential trade-offs between wood production, ecosystem services and forest resilience.

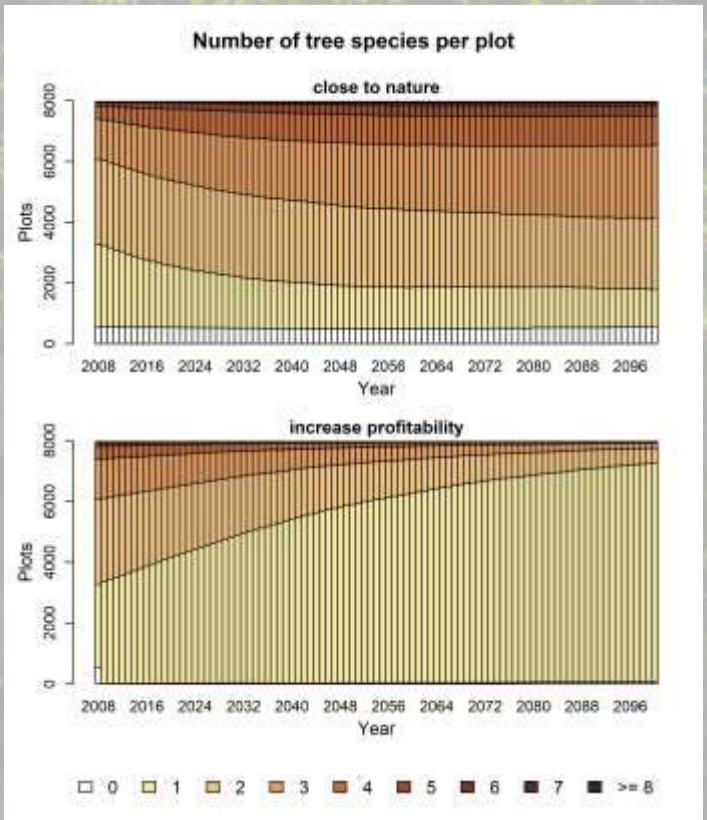


**Figure 2:** *Number of tree species at each forest inventory plot for the two scenarios "close to nature" and "increasing profitability" until the year 2100. Results from the forest development simulations from Austria (CALDIS model).*

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# INNOVATIVE JOINTS IN HARDWOODS

## hardwood_joint



The use of hardwood species in European timber engineering is increasing, knowledge on how to join two hardwood pieces is however lagging behind. Hardwood_joint tackles this, by looking into four fastener types promising for hardwood structures and by complementing experimental methods with engineering-oriented numerical models. In addition, hardwood_joint looks into joint optimisation. For instance, joint stiffness and capacity can be increased by modifying the timber surfaces. As everybody else, also hardwood_joint suffered from COVID-19 in 2020 and 2021, leading to only online meetings and above all closed laboratories. We are still on track and could carry out the following work, albeit at a slower pace.

Concerning small diameter fasteners such as ***nails*** and ***staples*** loaded perpendicular to their axis, a simple testing protocol was developed that allows for quick and cheap assessment of the feasibility to insert these fasteners in undrilled hardwood. Suitable fasteners identified applying this protocol were used to perform joint tests to develop and validate design models.

**Figure 1:** *Row shear failure mode of a group of three axially loaded screws. (Karlsruhe Institute of Technology, LERMAB Epinal and Technical University of Graz ).*

Smooth ***dowels*** as large diameter fasteners loaded perpendicular to their axis are relevant fastener types in engineered structures such as large trusses or frames. Due to the higher density of hardwood in comparison to softwood, novel failure modes were observed in dowelled joints in hardwood. An analytical design model was developed to capture these, which is currently verified performing bespoke tests. Furthermore, increased joint capacities were observed that are not represented with current design rules. An innovative test setup was developed that is able to measure normal forces along the dowel axis, which lead to the observed increased capacities.

**Figure 2:** *Detail of rough surface. (Karlsruhe Institute of Technology, LERMAB Epinal and Technical University of Graz ).*

***Self-tapping screws*** are probably the most relevant fastener type for engineered structures, particularly if their high properties in direction of their axis can be activated, which lead to superior stiffness and capacity. As screws and fasteners never come alone, joints with groups of axially loaded screws were examined (example shown in Fig. 1), where the focus lay on the development of boundary conditions within which practitioners will be able to design these joints and predict their capacity and behaviour. Extensive testing series were carried out, which currently are analysed and used to validate design models. Still ongoing are tests that look into the long-term behaviour of such joints.

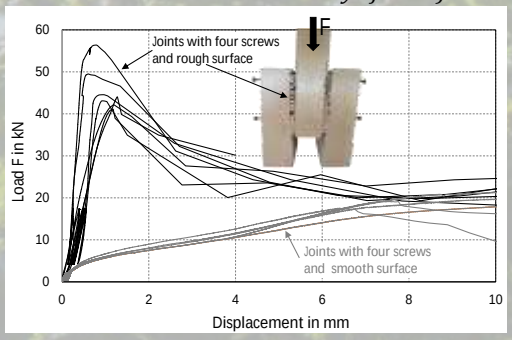


**Figure 3:** *Load-displacement curve of joints without and with rough surfaces. (Karlsruhe Institute of Technology, LERMAB Epinal and Technical University of Graz ).*

Very promising are modifications of surfaces of timber pieces that shall be joined together. These surfaces are roughed (Fig. 2), which leads to increased friction and hence increased stiffness & capacity (Fig. 3). Good news is that these ***rough surfaces*** can be produced with automated machinery.

Finally, one of the most important packages in engineering research is ***numerical modelling***, as these models are indispensable to validate tests and simple design-oriented analytical models (particularly to estimate joint stiffness). Additionally, parametric studies can be carried out with such models, leading to a decreased experimental effort. An engineering-oriented model was developed, modelling the fastener as a plastic beam sustained by plastic springs along the fasteners that represent the surrounding timber. Only standard test results such as embedment tests are

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# SMALL DIAMETER WOOD UTILIZATION WITH INNOVATIVE STAND MANAGEMENT FOR MULTIFUNCTIONAL FORESTS AND A GROWING SUSTAINABLE BIO-ECONOMY



**The SMALLWOOD project does R&D work on new technologies that increase efficiency of sustainable management and utilization of different types of small diameter wood. This newsletter presents results from two SMALLWOOD studies. One about the interest and willingness of family forest owners (FFOs) to do whole tree thinnings of young dense stands (Kronholm et al. 2020). The other is about harvesting of small trees from roadside verges (Fernandez-Lacruz 2020).**

Family Forest Owners (FFOs) own the majority of forestland in Europe and are important suppliers of raw materials to the forest industry. One way to increase overall biomass supply is to replace traditional pre-commercial thinning operations, where fallen stems are left in the forest to rot, with whole-tree harvesting of small-diameter trees using novel technologies and methods (Figure 1). This will however require willingness of the FFOs to shift their management practices. The objectives were to elucidate FFOs' perceptions of management and thinning operations in young dense forests and clarify which factors could potentially affect their willingness to implement whole-tree harvesting in young dense forests. Data were collected through a survey to a random sample of 842 FFOs in Sweden, with a response rate of 53.4%. FFOs in general are positive towards implementing whole-tree harvesting in young dense stands, and often also willing to promote the development of suitable stands. Factors such as forest size, geographical location, distance from home to their forest, degree of self-employment and current need for cleaning were found to affect their attitudes. The study highlights that the development of cost efficient techniques and methods is important if the industry wants to increase the FFOs' willingness to engage in whole-tree harvesting in young dense forest stands and thereby increase the supply of biomass.

**Figure 1**: A *young dense forest stand with a lot of biomass (Tomas Nordfjell).*

Kronholm, T., Bengtsson, D., & Bergström, D. (2020). Family Forest Owners' Perception of Management and Thinning Operations in Young Dense Forests: A Survey from Sweden. Forests, 11(11), 1151.

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# SMALL DIAMETER WOOD UTILIZATION WITH INNOVATIVE STAND MANAGEMENT FOR MULTIFUNCTIONAL FORESTS AND A GROWING SUSTAINABLE BIO-ECONOMY



Despite the large biomass potential, current management practices for roadside verges or strips beside agricultural fields consist of regularly cutting the vegetation and leaving it to rot in situ (Figure 2). Regular vegetation clearing is crucial for safety and functionality. This study considered the cost-efficiency of a mechanized harvesting system, using a harvester and a forwarder to maintain the verges of a forest road. Cutting a 2.5-m wide swath on each verge removed between 32 and 112 dry t/ha (16–56 dry t/km of road) of biomass. Analyses showed that the use of forest machinery to cut and extract biomass from roadside verges can be cost-competitive compared with motor-manual clearing when the average tree height is above 7m. As this biomass has to be cleared anyway, a mechanized harvest could partially or fully offset maintenance costs. When setting cutting intervals, a trade-off needs to be made between larger biomass production and maintaining a clear and safe road. Reports from DEMO events and more information about the SMALLWOOD project are available at: www.smallwood.eu/


**Figure 2:** *Dense strips with young trees beside agricultural fields and roads that has to be removed for their functionality ( Tomas Nordfjell).*

Fernandez-Lacruz, R., Edlund, M., Bergström, D. & Lindroos, O. (2021). Productivity and profitability of harvesting overgrown roadside verges – a Swedish case study, International Journal of Forest Engineering, 32:1, 19-28.

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# RESOURCE-EFFICIENT AND DATA-DRIVEN INTEGRATED LOG AND BOARD STRENGTH GRADING (READISTRENGTH)

Wood and wood products play an important role in Europe aiming at expanding the sustainable bio-based economy and successively reduce the dependence on fossil resources. The READiStrength project focuses on the production of wood material for the large area of construction timber products. In that area strength grading is a pre-requisite for sawn wood to be used for advanced construction and in engineered wood products, like glulam or cross-laminated timber. **To make best use of Europe's wood resources in the future, the READiStrength project aims to improve current concepts of saw timber strength grading towards flexible and adaptive approaches prior to conversion at the raw material stage**.

**Objectives**

- Develop roundwood strength grading approaches for different specifications of construction timber or glulam, for contrasting industrial production systems of large high-end sawmills or smaller rural sawmills in European regions.
- Develop approaches for a continuous flow of wood quality information in the wood value chain for optimized strength grading.

- **Expected effects and results**

- Combined knowledge in log X-ray and CT scanning, sawing optimization, traceability and sawn timber strength grading to develop combined log and board strength grading concepts supported by newest technology.
- Application of the novel concepts to important softwood species of European economic relevance and to regional, less used softwood species in the research design will enable a synchronous evolution of strength grading applicable for all softwood species;
- -Grant new insights in the strengths and weaknesses of each species with respect to construction timber products.

- **Arrangement and implementation**

- Novel strength grading scenarios for timber will be defined based on proven industrial standard and recent technology in roundwood scanning. Interviews in the sawmill industry to depict the scanning technology and grading specifics and adapt new approaches for regional sawmill industry.
- 430 logs of softwoods from Sweden, Austria and Germany and their 1230 sawn boards are characterized and tested for strength. Information is collected according to a joint protocol for cross-referencing in data analysis and strength modelling.

- **First two years of project work**

Interviews have been conducted with sawmill companies with important European manufacturers of scanning technology. State of the art, the industrial perspective on strength grading together with novel strength grading scenarios for future is summarized in two reports. In each country the extensive data collection of roundwood and sawn timber characterization measured in different sawmill processing steps is completed. Our work now focuses on modelling of strength grading scenarios, the core part of the project.



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# GREENLANE-FAST-TRACKING VALUE AND RESILIENCE OF INDUSTRIAL WOOD SUPPLY



***The overall goal of the project is to develop a virtual supply chain laboratory environment for challenging climate scenarios. The focus is on implementing weather-driven models for wood quality and seasonal availability.***

Extended transport throughput times lead to wood value losses resulting from fungi, insects or changing mechanical/chemical properties. To guarantee that harvested wood arrives at industry with the specified quality fulfilment, well-coordinated transport management is essential. The project focus during the last year has been on the empirical analysis of weather effects on wood quality and availability.

Regarding the modelling of how wood value develops over time, an integrated weather-driven framework for wood quality prediction was developed (IBM-model). The IBM-model integrates the main operational value drivers: Insects (I), Blue stain (B) and Moisture content (M). The IBM model enables value-tracking of log stacks in the forest based on the annual progression of weather parameters. Earlier models and raw data were validated, new models fitted and adapted to the project context. The model was subsequently developed to establish digital twins for driving value-tracking in the virtual laboratory environment.

Photo by Simon Berger on Unsplash

With the increasing occurrence of frost-free winters, new methods are needed to track and predict road availability based on actual weather conditions. To meet this challenge, a new model was developed based on historical road use and weather conditions in order to infer relative road bearing capacity (RBC). The RBC-model captures the main operational drivers for seasonal availability (temperature, precipitation and snowdepth) for public and private roads of specific surface deposit materials.

The model captures and quantifies the local insight guiding management decisions through necessity (only option during difficult weather) and opportunity (possible option for good weather). As for the IBM-model, the RBC works as a digital twin tracking the effects of operating conditions on road availability and guiding management options in the virtual laboratory environment.

The initial frameworks for both the IBM- and the RBC models were presented at the NB-Nord research conference (Copenhagen) in Sept 2020. The final models are submitted to the upcoming FORMEC/COFE conference (Corvallis) in Sept 2021.

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StrongComposite

# STRONGCOMPOSITE – A NOVEL MATERIAL CONCEPT FOR HIGH STRENGTH CELLULOSE COMPOSITES



## Spider silk can be used as a novel wet adhesive for cellulose

Nature provides us with excellent materials that can be used for industrial applications. Both, spider silk and cellulose are materials with outstanding mechanical properties. Cellulose is particularly convincing since it is available in large quantities and it is especially strong at the molecular level. Spider silk proteins, on the other hand, show an incredible toughness.

**Figure 1:** *An orb weaving spider from the family Araneidae on a wood log. (Jennifer Teerstegen)*

We utilize a delignification and densification process, developed by our collaboration partner at ETH Zürich, to obtain an infiltration matrix for our spider silk-based adhesive. The process of delignification, and the fact that the cellulose is stored under wet conditions afterwards, leads to an advantage of using never-dried wood but also to a need to develop a wet adhesive. Here we make use of recombinant spider silk proteins which undergo liquid-liquid phase separation, also called coacervation. This process occurs at high concentrations and we are studying how it is connected to the adhesive properties of the silk protein. The recombinant silk protein we use consists of an engineered version of the drag line silk from the common garden spider Araneus diadematus and is modified by addition of cellulose binding modules as the terminal groups which should enhance the binding of our silk protein to the cellulose. The aim is to reach good infiltration into the cellulose matrix as well as high entanglement across the interface.

***Figure 2:*** *A lap shear sample prepared with delignified spruce veneer and recombinant spider silk protein. (Jennifer Tersteegen)*

Lap shear samples made from delignified spruce veneer, glued with the silk protein, are able to reach high adhesive strength compared to other biobased glues reported in the literature.

**Laura Lemetti, Jennifer Tersteegen and Markus Linder**
**Biomolecular Materials Research Group**

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(1 of 2)

# DYNAMIC RESPONSE OF TALL TIMBER BUILDINGS UNDER SERVICE LOAD

DynaTTB

The overall objective of the DynaTTB project is to identify experimentally a number of full-scale TTB structures within Europe and, based on these results, develop representative FE-models for predicting the vibration response of TTBs exposed to wind-induced dynamic loading. One important part of this work is to quantify the structural damping in a built TTBs as this parameter is not included in the design codes of today.

In the project, measurement of dynamic properties of six full-scale buildings have been conducted using Forced Vibration Tests (FVT). In these tests, a shaker has been placed in the buildings and a vibration force applied to simulate forces and movements of the same magnitude as can be expected by wind loading. The buildings have also been equipped with accelerometers at different levels within the building. The data from these measurements have been used to evaluate resonance frequencies, mode shapes and damping of the building. Using shakers with varying forces also make it possible to evaluate the amplitude dependency of the dynamic properties accurately. These data shows that the damping of these relatively light buildings behaves non-linearly i.e., varies with amplitude in a way that it does not do for more heavy buildings. Measurement campaigns are planned for a few more buildings but has so far been postponed due to travel restrictions within Europe.

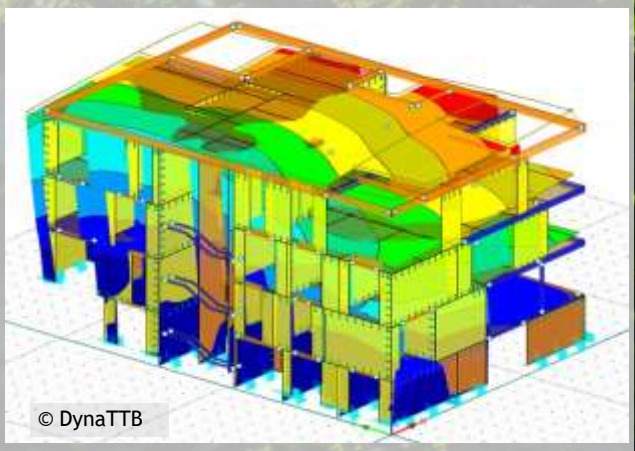


**Figure 1:** *The Flower Valley project in Ljubljana, Slovenia, during construction and a FE-model of the same building (done in collaboration between InnoRenew and ZAG in the InnoCrossLam project). (DynaTTB)*

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# DYNAMIC RESPONSE OF TALL TIMBER BUILDINGS UNDER SERVICE LOAD

DynaTTB

Finite element models have also been created for all the buildings. These models, based on best engineering estimation, has in a first step be used for planning the measurement campaigns for these buildings. In the next step these models have been, and will be further, improved for prediction of the real response of the buildings. The models are used to establish strategies for modelling full scale buildings in the serviceability limit stage. The models are also used for sensitivity analysis to learn which parameters are most important to model correctly to predict the dynamic properties. The studies show that it is important to include good data for stiffness of connections and reasonable values for masses. The effect of additional mass and stiffness of non-load bearing elements such as screeds, interior walls and facades are also important to include in the models in the serviceability limit stage. To complement the measurements and FE-models on full-scale buildings, effort is also done on modelling components and connections such as dowel connections in beam-column connections and diagonal-column connections as well as complete trusses.


**Figure 2**: *Accelerometers placed on the pergola of the Mjöstornet building in Norway (NTNU) and measurements on a glulam truss in Sweden (LNU and RISE).*

The results will be summarized in a Tall Timber Buildings Design Guideline – Serviceability limit stage. The guideline will include chapters for each building as well as recommendations on how to measure dynamic properties of tall timber buildings and recommendations on how to create FE-models working in the serviceability limit stage. The data and calculation models will also be included in the design codes in the future to facilitate optimization of the design of Tall Timber Buildings.

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# MANAGEMENT FOR MULTIFUNCTIONALITY IN EUROPEAN FORESTS IN THE ERA OF BIOECONOMY

**Project:** In most EU countries, various national policies guide forest use, but often with competing policy objectives, which leads to divergent management paradigms. Incoherent policies may negatively impact the sustainable provision of forest ecosystem services, particularly under climate change (e.g. wood, berries, game, recreation and water). There is uncertainty among policy makers about the impacts of policies on the real world. MultiForest bridges this gap between forest ecosystem research and the information required for policy-making.

**News:** The MultiForest team organized an international online stakeholder workshop in May 2021 to present the outcomes of our national policy analysis. Ca 35 stakeholders from FI, SE, NO and DE participated in the workshop, representing forest owners, forest industry, NGO´s and government agencies. After a general part for stakeholders from all countries, the stakeholders were split up in national groups to discuss the specific national results in more detail. Stakeholders got an overview on coherency of policies in each country, and how management would need to look like to achieve the divergent policy demands for forest ecosystem services. We presented our policy-based optimal landscape forest management programs that would be most effective in addressing targets of national sectoral policy in each country: forest strategy, biodiversity strategy, and bioeconomy strategy. The landscape management programs were based on nation-wide forest simulations of possible future alternative management practices and climate change impacts. To develop optimal management programs, we used the multi-objective optimization tool, which we had developed together with our business partner FinnOpt within this ForestValue project (see link below). The tool was used for national optimizations by each project partner. Our results highlight that the national forest strategy proved to be the most comprehensive policy in each country with the highest number of targeted ecosystem services, while policy strategies for biodiversity and bioeconomy stated the fewest ecosystem service targets. These in-coherences among sectoral policy targets cause a mismatch in terms of the optimal landscape management and potential shortcomings in providing forest ecosystem services sustainably. These findings are particularly relevant for improving policy mixtures. The outcomes can provide leverage points for better integration of multiple forest ecosystem services in future policies and can help to overcome socio-ecological land-use conflicts in forests. Because of the importance of the results, stakeholders were very interested and many fruitful multilateral discussions took place in the workshop.

**Outlook:** During the workshop, our partner IIASA (see below) also presented the expected timber demands that countries should provide in the future to reach the EU climate targets. Next, we will use our optimization tool to study how well aligned the national policies are in relation to the EU climate policy targets. Those results we will present to our stakeholder in a future workshop, in which stakeholders also might experiment with the optimization tool by their own to find out what combination of forest managements would fit best with their particular requirements, and what implications that would have on several ecosystem services.

**Partners:** University of Jyväskylä (JYU), International Institute for Applied Systems Analysis (IIASA), Technical University of Munich (TUM), Swedish University of Agricultural Sciences (SLU), Finnish Environment Institute (SYKE), Norwegian Institute of Bioeconomy Research (NIBIO), FinnOpt Ltd.

**Demo link to the optimization tool:** https://github.com/maeehart/MultiForestDemonstration

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 773324

# MANAGEMENT FOR MULTIFUNCTIONALITY IN EUROPEAN FORESTS IN THE ERA OF BIOECONOMY

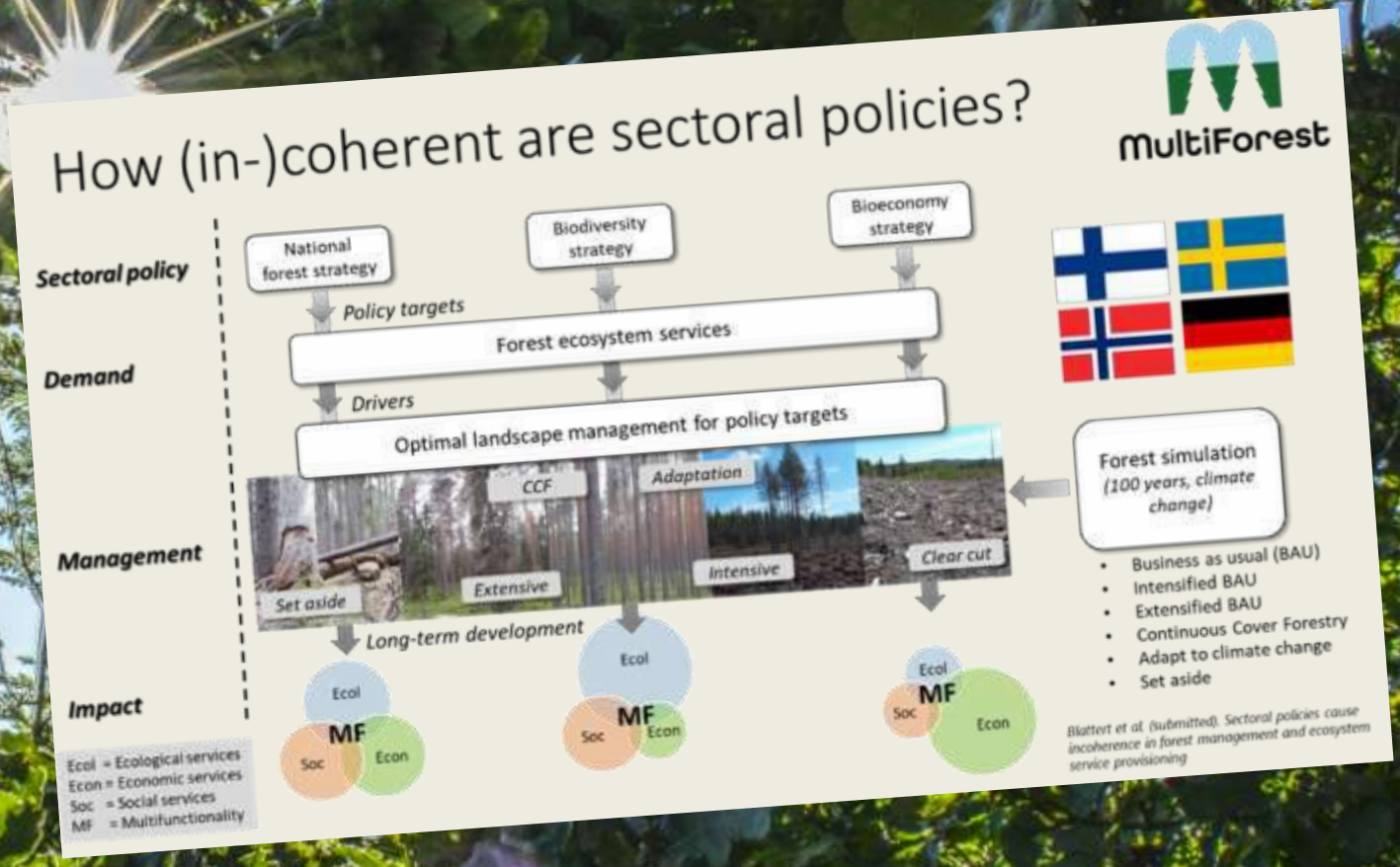


***Figure 1:*** *Infographic showing how coherent/incoherent sectoral policiers are. (University of Jyväskylä).*

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# FROM FUNDAMENTALS TO VALORIZATION: ENZYMATIC OXIDATION OF CELLULOSIC FIBRES AND UNDERLYING MECHANISMS

The project 'From fundamentals to valorization: Enzymatic oxidation of cellulosic fibres and underlying mechanisms' (FunEnzFibres, 2019-2022) explores novel enzymatic methods for sustainable processing of cellulosic fibres into novel products such as sustainable textiles, coatings and adhesives. (1). The project combines top-notch expertise in enzymatic cellulose oxidation (NMBU), advanced cellulose analytics (BOKU) and enzymatic fibre processing and enzyme production (VTT).

The enzymes used in the project originate from fungi that use them in nature for deconstruction of plant biomass. In FunEnzFibres, enzyme production in large quantities has been possible after the genes encoding. These novel enzymes have been transferred into an industrial microbial host capable of effective enzyme production (2, 3). Knowledge-driven process and product development requires the availability of suitable analytical methods. Therefore, sophisticated analytical methods for following enzyme action in cellulosic fibres have been developed. For instance, a novel technique has been developed which allows to assess how deep in the fibre wall the enzymes can enter (4). The different enzymes studied in the project were found to produce different types of modifications to the fibres and modification was found to be also dependent on treatment conditions, indicating that enzymatic 'tailoring' of the fibre properties should be possible.

The final project year focuses on application studies in the production of regenerated textile fibres and fibrillated cellulose. In textile production, there is an urgent need for environmentally benign production technologies that could replace the use textile fibres with adverse environmental effects such as microplastic release. Increased used of man-made cellulosic fibres (MMC) is anticipated and FunEnzFibres develops novel enzymatic pre-treatments that could further lower the environmental effect of MMC production.

Bio-based solution are also sought after in the field of coatings and adhesives used in the construction industry. Here, development of solutions based on fibrillated cellulosic fibres offer possibility create construction materials, with safe and sustainable production and easy recycling.

*Website*: https://www.nmbu.no/en/projects/node/38547

*Research Gate page*: https://www.researchgate.net/project/From-fundamentals-to-valorization-Enzymatic-oxidation-of-cellulosic-fibres-and-underlyig-mechanisms-FunEnzFibres

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# TOWARDS INTENSIFICATION OF CONIFER PRODUCTION THROUGH MULTI-VARIETAL FORESTRY BASED ON SOMATIC EMBRYOGENESIS

MULTI FOREVER

## Direct somatic embryogenesis from mature tissue of selected conifer trees: still the "Holy Grail" for plantation forestry - at least it comes into sight, as now demonstrated in Norway spruce!

MULTIFOREVER develops a novel approach for vegetative propagation of improved varieties in economically relevant conifers called somatic embryogenesis (SE). The technology has the potential to produce multiple seedlings, true to type (a clone), from one individual. Several steps have to be controlled, from initiation and multiplication of embryogenic tissue to production of mature somatic embryos and conversion to somatic plants similar to standard seedlings. Our challenge is to develop a value-added chain and joint strategy to bring high-quality somatic trees at acceptable costs to implement multi-varietal plantation forestry, i.e. the use of tested varieties. Both productivity and diversity at the stand and/or landscape level can be managed through the combination of different varieties. This is a promising way towards much more flexibility for efficient deployment of productive and resilient varieties to face climate change and associated environmental threats.

SE is an in vitro process typically starting from immature seeds, more specifically from the embryo within. This is the most advanced technology currently being refined for industrial scale-up. As the future performance of individual somatic seedlings obtained from seeds is unknown for many years, SE must be complemented with cryopreservation of embryogenic tissue in a juvenile stage, while somatic plants obtained from these tissues are field tested. After the evaluation period, the best trees of various backgrounds can be multiplied by SE from the cryostock. SE initiated from seeds therefore provides an access to the retroactive vegetative propagation of selected trees.

Testing trees in the field is a long process, typically of 10-15 years and more in conifers. It would make a big difference (saving valuable time and other resources) if embryogenic cultures could be initiated from any selected tree with known characteristics, using for example their buds as explants. New varieties would be designed (by breeders) and deployed (by biotech companies and forest nurseries) much more easily, quickly and at the lowest cost.

SE from mature trees obtained by sexual reproduction is still highly challenging in conifers (Trontin et al. 2016, p. 211-260). After reference work in white spruce (Klimaszewska et al. 2011), the full SE process (from initiation to plant regeneration) could be demonstrated in Norway spruce (Varis et al. 2018) from bud explants of 4-6 years old somatic trees (Figure 1). Although obtained at a rather low frequency, SE initiation could be repeated by LUKE during MULTIFOREVER from one responsive genotype. Regulatory mechanisms determining the embryogenic pathway are under study in collaboration with UPSC to understand what triggers this remarkable process. On this shared successful experimental basis for Norway spruce, trials are underway in pine species at FCBA (maritime pine) and NEIKER (radiata pine).

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# TOWARDS INTENSIFICATION OF CONIFER PRODUCTION THROUGH MULTI -VARIETAL FORESTRY BASED ON SOMATIC EMBRYOGENESIS

MULTI FOR EVER



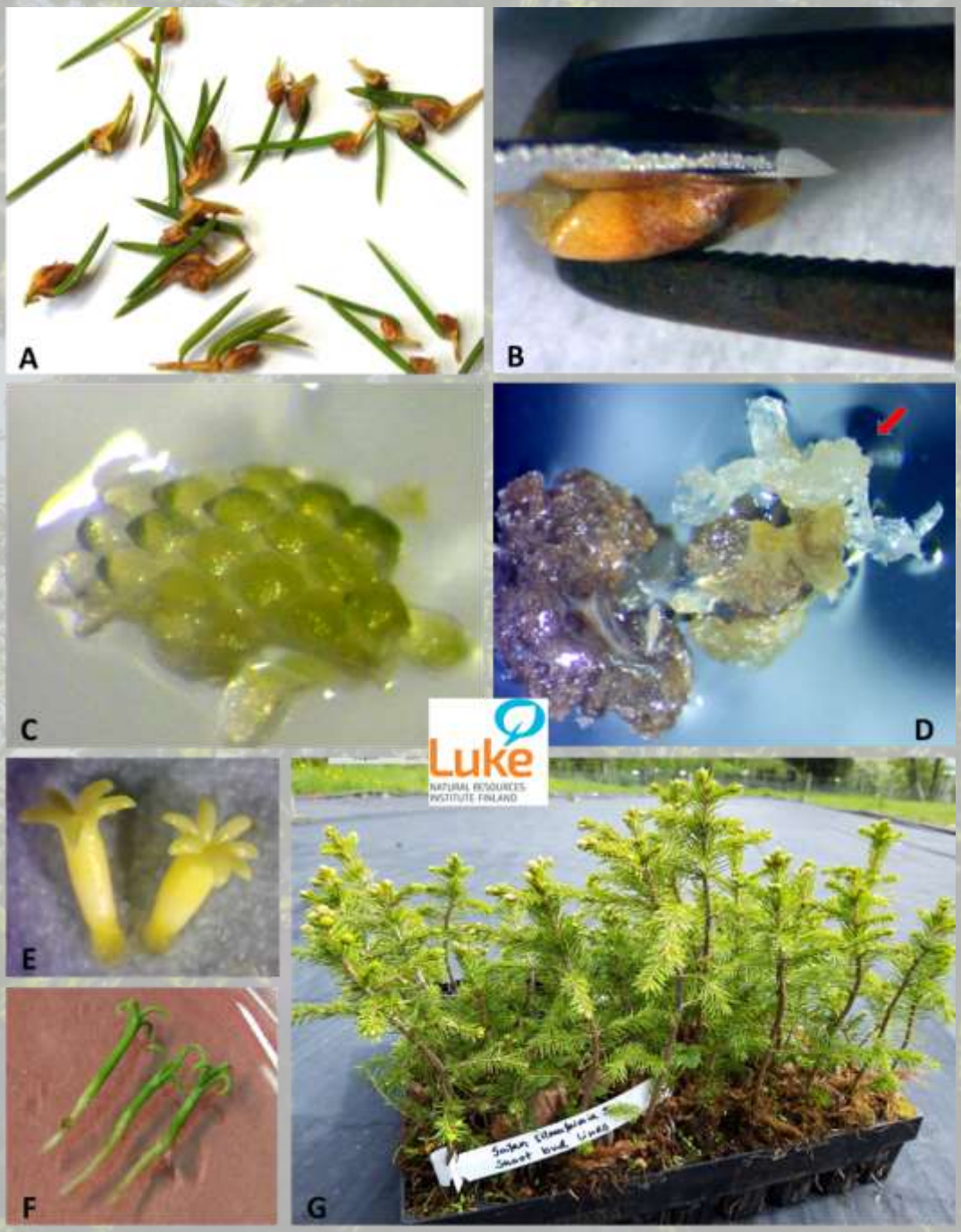


**Figure:** *Somatic embryogenesis in Norway spruce from bud explants.*

A. Shoot buds collected on 4-6 years old field-grown somatic plants

B. Dissection of a single bud using forceps and scalpel

C. Bud explant with primordial needles on induction medium;

D. Initiation event (arrow) from bud explant. The white and soft embryogenic tissue is growing in the vicinity of harder, brownishing, non-embryogenic callus;

E. Cotyledonary somatic embryos obtained from the initiated embryogenic tissue;

F. Germinated somatic embryos;

G. Somatic seedlings obtained from shoot bud explants.

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# NOVEL BUSINESS MODELS AND MECHANISMS FOR THE SUSTAINABLE SUPPLY OF AND PAYMENT FOR FOREST ECOSYSTEM SERVICES

NOBEL



The NOBEL project investigates novel business models to sustainably supply forest ecosystem services beneath timber like biodiversity, clear water, protection from erosion, recreation opportunities, cultural heritage, live stock and other non-wood forest products.

***Figure 1:*** *A image showing a mushroom and a dog (BOKU).*

A first analysis of success and failure criteria carried out, that long-term projects with state-involvement have the best chances to lead to sustainable outcomes in enhancing and appreciating forest ecosystem services. Globally over 100 cases have been screened so far with in-depth interviews of the most promising. Researchers at the moment have the chance to evaluate even more examples.

The project NOBEL incorporates five own case studies in pilot demonstrations in Portugal, Spain, France, Sweden and Austria with different focuses. Therefore, different indicators were selected to describe each regions priorities best. The indicators were grouped according to the international CICES convention. The approach for upscaling effects based on remote sensing indicators was also tested. As expected some criteria are easier to detect from airborne laser scanning (ALS), others especially below canopy still need terrestrial inventories.

Simultaneously, forest owner's opinions and preferences about ecosystem services were requested via a survey. France did the pilot for this survey and their results are currently processed for publishing. Additionally the questionnaire was translated and adapted for an international comparative study of Portuguese, Spanish, Swedish and Austrian landowners. These results are expected in autumn.

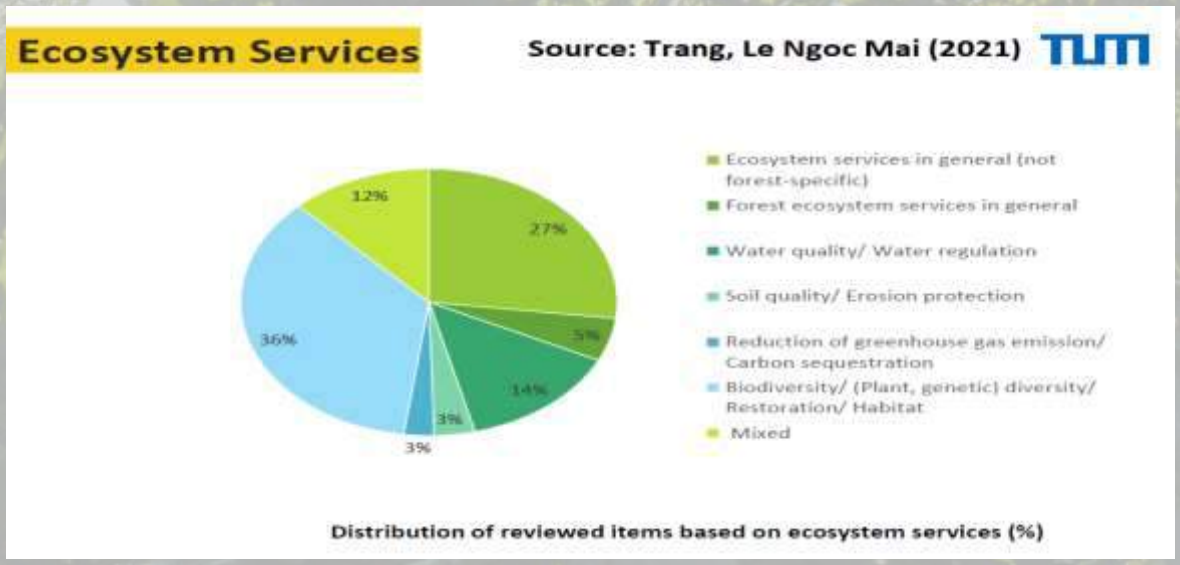


***Figure 2:*** *A Graph showing the distribution of reviewed items based on ecosystems services (TUM).*

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# NOVEL BUSINESS MODELS AND MECHANISMS FOR THE SUSTAINABLE SUPPLY OF AND PAYMENT FOR FOREST ECOSYSTEM SERVICES

NOBEL



Based on the landowner's preferences and needs different management scenarios are currently under development. After collection of the baseline scenarios (business-as-usual) of each case study scenario paths and goals are bundled to create packages of which potential buyers can choose within an auction. An platform based on the ECOSEL project of the University of Washington is therefore adapted to European needs. It will incorporate these bundles to simulate auction preferences on the basis of buying options as well as different auction design patterns. An analysis of influencing parameters was undertaken. Auction participants e.g. may decide differently, if they can interact with each other building consortia with equal interests or if they have a second bidding round after their preferred option has failed and they could replace or remove their stake.

The policy framework analysis is upcoming now and an international conference is planned from 28-30th September 2021. The conference committee already decided about the sessions in which final and intermediate results of two projects NOBEL and SINCERE will be presented publicly. The event is designed as hybrid conference in Brussels and online to reach out policymakers on the one hand and to enable a broad audience to participate on the other even under potential COVID restrictions.

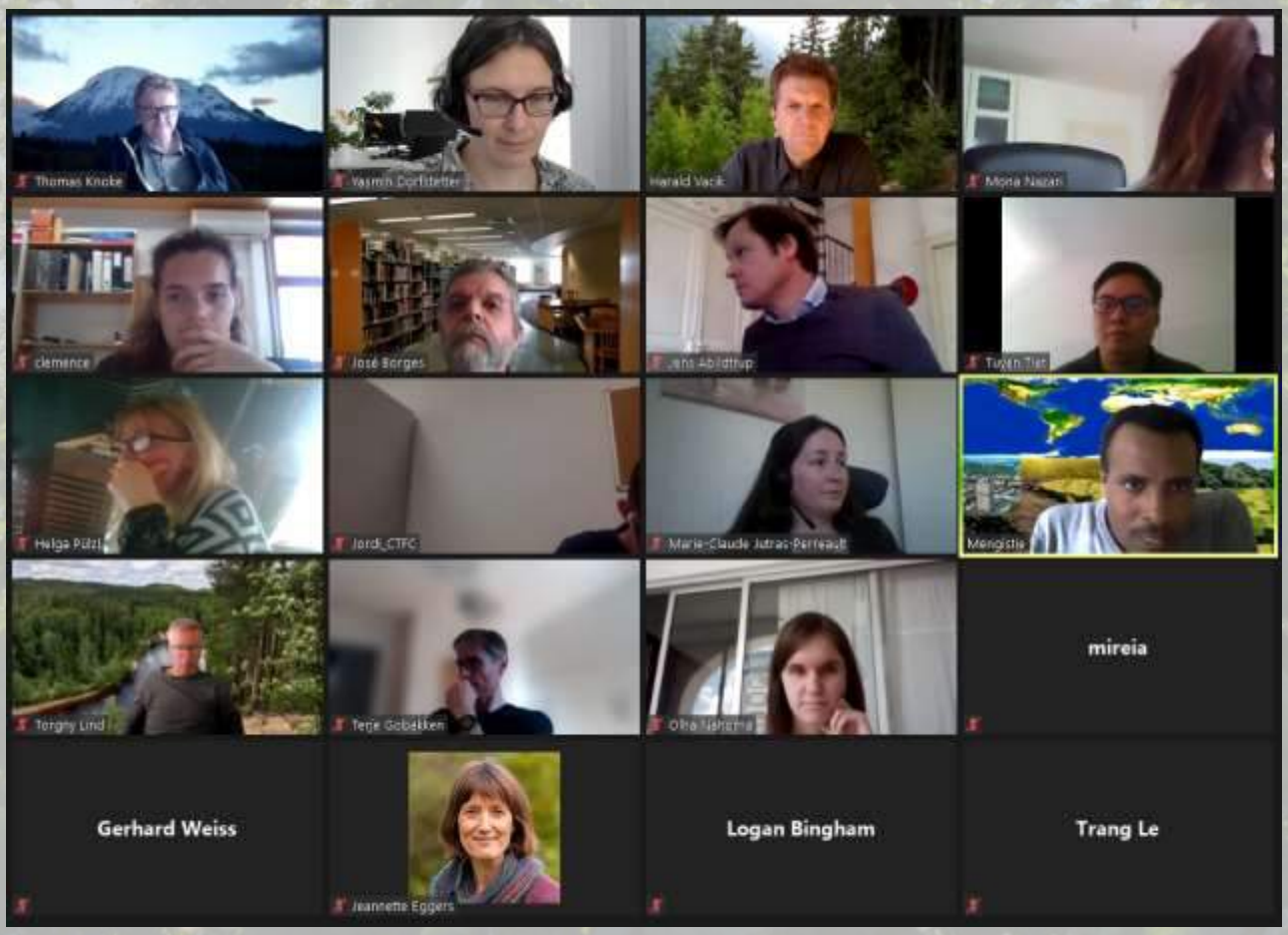


***Figure 3:*** *Screenshot of NOBEL Zoom meeting (BOKU).*

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# INNOVATIVE DESIGN FOR THE FUTURE – USE AND REUSE OF WOOD (BUILDING) COMPONENTS



Within the InFutUReWood project new designs for wood buildings are developed following the concept of an easy disassembly, reassembly and therefore reusability of the building elements. Various solutions for building frames from different European countries are developed. Five ongoing case studies evaluate a method to take a current frame design and adapt it for Deconstruction & Reuse (DfDR). Further on, a tool to assess the deconstruction and reuse potential of a building through an indicator system is developed.

In one case study, a pre-fabricated detached single-family house is modified together with the manufacturer to facilitate the disassembly of the building elements and their future reuse.

Thus, a design for disassembly and reuse will come with trade-offs and will not per se improve the environmental performance. Therefore, a life-cycle based evaluation of the building is important to determine the environmental impacts and costs of the new building design. In the assessment, the current state of the art construction is compared with the newly developed design for disassembly and reuse. Life cycle assessment methodology (LCA) along with a life cycle costing (LCC) will be applied and carried out in close cooperation with the respective industry partners and the engineers and architects developing the new construction designs. The biggest challenges lay in the collection of inventory data on the manufacturing and construction of the building, for the newly developed concept. The study is currently ongoing, and results will be available at the end of the project.

Also, products of reused timber and a combination of new and hybrid were tested. Figure shows how a 3-ply CLT panels made of reused spruce is tested for bending. In the test group of 9 elements neither the maximum failure load, bending strength, or stiffness were significantly impacted by the base timber. A more ductile failure mode was observed with the CLT panels comprising reused wood, compared with the panels comprising of new timber only. Additional testing of hybrid panels is scheduled. A report about an inventory, deconstruction and quality of recovered wood is published. The data for the study was gathered from the seven countries, Finland, Germany, Ireland, Slovenia, Spain, Sweden, and the UK. It was collated from visits to demolition sites, waste recovery, sorting, and timber processing facilities, along with responses to a questionnaire. Also testing properties and grading of recovered wood was done with visual and machine to derive grading criteria. To confirm the grading criteria destructive, four-point bending tests were done. The strength of timber is showing promise, as the undamaged wood has similar characteristics to new wood.

***Figure 1:*** *Image showing the testing of a 3-ply CLTpanel at NUIG (NUIG).* ***Figure 2 and 3:*** *Image showing the testing ca 544 years old reclaimed oak beams in bending at the Laboratory of UL FGG (UL FGG)*

In October 2020 we held a Webinar with 145 listeners from the whole world. Extra material and 14 videos are published on www.infuturewood.info/on-demand/ and a state-of the art report about DfDR has been published.

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# INNOVATIVE FOREST MANAGEMENT STRATEGIES FOR A RESILIENT BIOECONOMY UNDER CLIMATE CHANGE AND DISTURBANCES

The I-Maestro project aims to test whether greater structural complexity improves the resilience of forests to disturbances in the context of climate change. It is based on the use of four forest dynamics models (4C, Salem, LandClim, Samsara2) applied at different scales (stand, landscape and country). It also includes the analysis of field data on regeneration dynamics (recovery) after major disturbances such as windstorms, fires or bark beetle damages. Different management and disturbance scenarios are tested with the models on three different landscapes and four different European countries (Poland, Germany, France and Slovenia) and over a period of 100 years.

In the second year of the project, the partners designed disturbance and management scenarios (led by PIK and EFI). The disturbance scenarios are developed thanks to the Database of Forest Disturbances in Europe (DFDE), which has been re-structured and published online in 2020 (openly available at https://dfde.efi.int/db/dfde_app.php). The new version of DFDE contains all the information stored in the old version of the database including more than 31000 records, plus new data that covers the period between 2000 and 2020. End of April 2021, the number of events increased to 85,000 records and efforts are still ongoing to further update the contents. The management scenarios are based on silvicultural management systems that are related to three management strategies: "intensification", "extensification" and "working for complexity". A first application on the Bauges study site was carried out and implementation in models is underway.

In order to better understand the link between disturbances and stand structure, the UAK partner, in collaboration with project partners, carried out a review article on the relationship between drought induced forest disturbances and changes in site conditions, nitrogen deposition and accelerated stand growth. Work is also underway on remote-sensing detection of stand weakness and dieback, in which Sentinel-2 data and data from LIDAR are used. Data on forest disturbances was collected in Poland for 2015-2020 and was used to study the relationship between disturbances, site conditions and stand structures.

For post windthrow recovery (analysed in Slovenia), all field work is complete and data analysis was finished in the spring of 2021. For the study on forest resilience following ice storm and bark beetle disturbance, half of the research plots were measured in summer and autumn 2020, while measurement of the other half started in early May 2021 and will be completed in summer 2021. Finally, most of the data for a pan-European study of forest recovery after disturbance have already been compiled, and analyses is planned for summer-fall 2021.

Since the beginning of the project, 11 scientific publications, one report and 12 communication outputs have been produced (see https://i-maestro.inrae.fr/publications/).

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# AVATAR: ADVANCED VIRTUAL APTITUDE AND TRAINING APPLICATION IN REAL TIME

## AVATAR Consortium proceeds Field Tests

The AVATAR Team successfully created the scientific foundation for the development of a forest machine operator assistance system. Despite Lockdown and Corona restrictions, field studies and further investigations were performed. The compilation of the results was an essential step for designing features of the coaching system.

In general, the AVATAR project aims to develop a digital coaching, assistance and feedback system for forest machine operators in highly mechanized harvesting systems, to improve productivity while reducing mental workload. The project contributes to efficiency improvements of Cut-To-Length (CTL) operations for enhanced timber utilization at higher value-added resource recovery. Alongside occupational health and safety, AVATAR supports the implementation of a sustainable and competitive bio-economy in Europe.

To reach this goal, each partnering organization further progressed in project work and especially in related field studies. Besides many other activities, ways of enhancing interaction of single grip harvesters and forwarders were analysed for resource efficient wood supply. In a field study, particular focus was given to potential efficiency improvements in forwarder loading by technical means. For example, time consumption per loading cycle was measured while using Intelligent Boom Control (IBC) and Rotating Cabins in contrast to reference cycles (no use of IBC and Rotating Cabin) of forwarder work. Results showed that this kind of technical assistance significantly reduces time consumption per loading cycle. Efficiency improvements depend on factors such as loading angle and loading distance. As loading is one of the most time consuming elements of the extraction process by forwarders, it is important to identify these kind of productivity determining factors for overall productivity gains of mechanized timber harvesting systems. In addition, these analyses help the AVATAR project to reveal further needs of technical assistance of forest machine operators in CTL-systems.

The AVATAR project is frequently present at scientific conferences. For more information visit https://www.uni-goettingen.de/de/631554.html.

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FIRENWOOD

# IMPROVED FIRE DESIGN OF ENGINEERED WOOD SYSTEMS IN BUILDINGS

FIRENWOOD is to ensure fire safe use of innovative, engineered wood systems in taller and larger buildings, by providing improved fire design models, validated by small- and full-scale fire tests as well as classification and test methods for adhesives with regard to elevated temperatures and fire.

**Figure 1:** *Finger joint of I-joist failed in adhesive (RISE)*


**Figure 2:** *Single lap compression shear tests. (MPA Stuttgart)*

During the second year, various tests have been conducted by FIRENWOOD partners in Norway, Germany, Sweden, and Estonia. Pull-out tests for bonded fasteners were carried out using test specimens with three joint thickness (0.1 mm; 1.0 mm; 3.0 mm) under both room temperature (20 °C) and elevated temperatures (up to 110 °C). Additionally, adhesive performances at elevated temperatures with scarf and finger joint specimens were investigated. Tension at elevated temperature tests up to 270°C were performed, scarf joints were tested at 200°C. Besides, small scale cross laminated timber (CLT), glue laminated timber (GLT) and finger joints were tested under cone heater, showing different behaviour of bondlines in a fire depending on the 11 adhesives used. Model scale furnace tests (TETTs (p.21 lower picture on the right)) with loaded I-joists were performed to verify the small scale test results. Model scale and full-scale furnace testing of GLT and CLT are planned. All tests of engineered wood made with 11 adhesives showed clear variation in fire behaviour (for example residual strength at high temperatures). The proposal for at least 3 classes for adhesive classification is made. The adhesive classes will help to choose the right calculation models.

Besides the experimental validation, efforts have also been made concerning improved fire design models for engineered wood systems. The calculation models for fire design of the I-joists have been proposed and the charring models for glulam and CLT have been improved and included in Eurocode 5. Design guidance for glued structural connections will be proposed. New and improved design models will take the adhesive behaviour in fire into account.



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FIRENWOOD

# IMPROVED FIRE DESIGN OF ENGINEERED WOOD SYSTEMS IN BUILDINGS

Based on the test results at different scales in fire and at elevated temperatures the classification model for wood adhesives used in fire resistant engineered wood structures will be developed. The technical knowledge generated in FIRENWOOD can be used by authorities and industries in future design standards.

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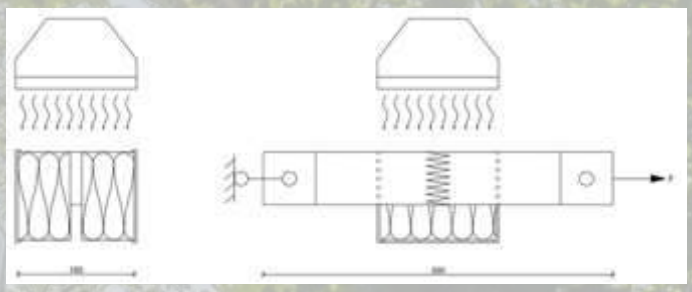

**Figure 3 and 4:** *Loaded cone heater method for Finger joints (RISE/TALTECT).*

**Figure 5:** *TETT test specimen tested at ambient temperature (20°C) (MPA Stuttgart).*



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# DELIVERING FINGERTIP KNOWLEDGE TO ENABLE SERVICE LIFE PERFORMANCE SPECIFICATION OF WOOD



We have clearly seen that researchers are a social collaborative species as we have progressed through one of the most challenging years of our professional lifetimes. To the huge credit of the CLICKdesign consortium we have found new ways to work (e.g. testing the use of building image data to validate aesthetical change characteristics), to collaborate (not another Teams meeting!) and to communicate the findings of our research (you're on mute!) – as we all had to do. We know its not easy, its been bumpy, but the results speak for themselves as we head into the final year of the collaboration.

We work on matters underpinning the utilisation and specification of wood in construction based on durability and performance related to service life. The CLICKdesign tool development led by Lund University has advanced considerably in the year plus of lockdown, based on three core modules for the specifier (i) decay (ii) aesthetics and (iii) insects and termites. In addition, case studies of the impact of decay on integrity and mechanical properties are being prepared by VTT. It is a numerical model which enables the user to zoom in on the location of their building or structure in Europe which automatically uploads climate data for the location. This provides default moisture content data for within a reference Norway spruce board and a service life value for that location. By implementing selections for design details (end grain, moisture traps, joints, shelter from overhangs), topography and shading further impacts on the moisture content and service life are revealed. The University of Göttingen and NIBIO teams have advanced our knowledge of decay and moisture related features (e.g. splashwater), allowing the user to clearly see the impact of their choices on service life. The second module has a robust time forecasting of aesthetic changes on wood surfaces - a vital component of functionality for exterior wood cladding and decking. The aesthetics model unfolds the surface of the building to create a UV surface map and combined with material data provides a simulation of surface wood appearance that interacts with the moisture dose from rain events associated.

**Figure 1:** *Mapping images of timber clad building having weathered and aesthetically changed. (ClLICKDesign)*

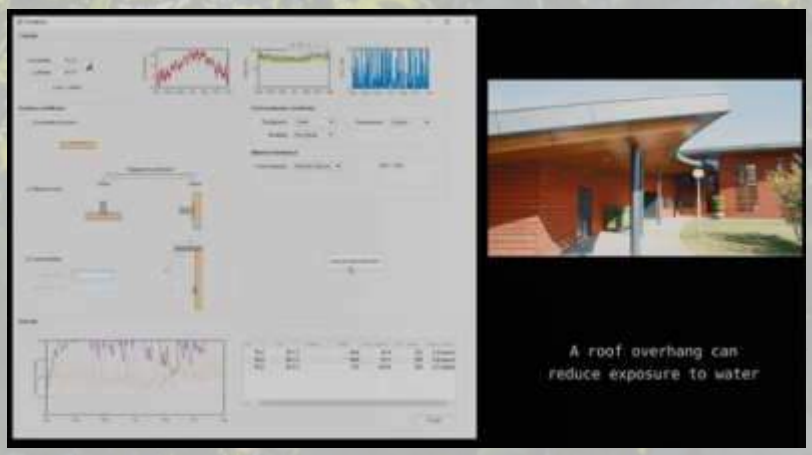


**Figure 2:** *Selection criteria on roof overhang ( CLICKDesign)*

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# DELIVERING FINGERTIP KNOWLEDGE TO ENABLE SERVICE LIFE PERFORMANCE SPECIFICATION OF WOOD



Aesthetics is a very human feature, and crucially thanks to the experts at InnoRenew this module also includes an interactive sliding scale of tolerance to aesthetical change of exterior wood surfaces on simple building archetypes. At our next meeting we discuss the proposal for the third module, the termite and insect performance measure from the team at FCBA and the University of Vigo, based on a probability of occurrence (a distribution map), materials insight and preventive measures.

We will be making the tool more widely available for piloting with groups of specifiers and architects in part virtually, but we also look forward to physical presentations and meetings to discuss and refine the tool.

CLICKdesign tool will help educate users as they can directly see the impact of their decisions on the moisture content and service life. But a significant new step has been taken with Nežka Sajinčič a PhD candidate at Faculty of Education, University of Primorska linking up with CLICKdesign. Content providing learning in a digital environment is being developed as part of the CLICKdesign tool to embed tutorials and explanatory videos. This will encourage engagement with an even wider audience including the public and ease uptake of the tool. We can't wait to show this!

**Figure 3:** *Decay module in the CLICKdesign tool the splashwater test rig (University Göttingen)*

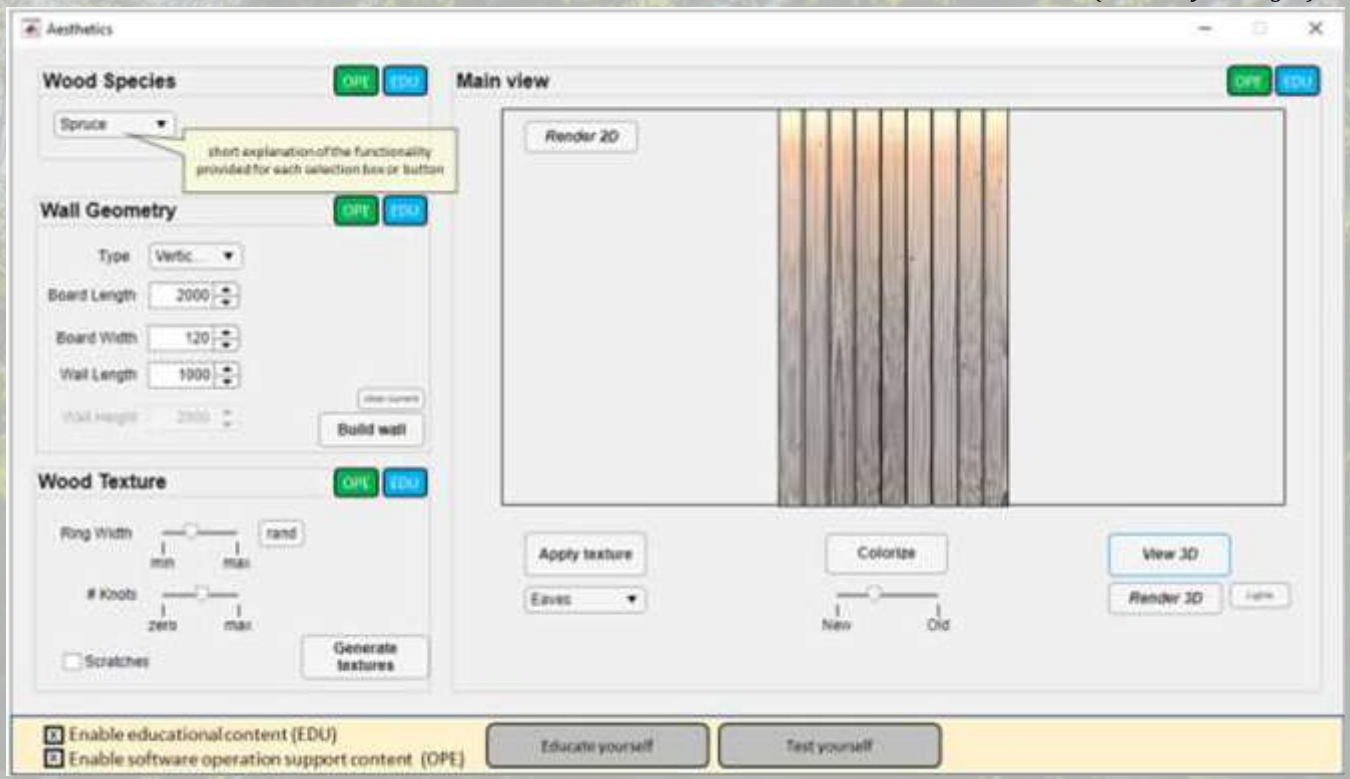


**Figure 4:** *A representation of the EDU educational buttons in the aesthetics module of the CLICKdesign tool. (ClickDesign)*

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# INNOVATIVE SOLUTIONS FOR CROSS LAMINATED TIMBER STRUCTURES

inno cross lam

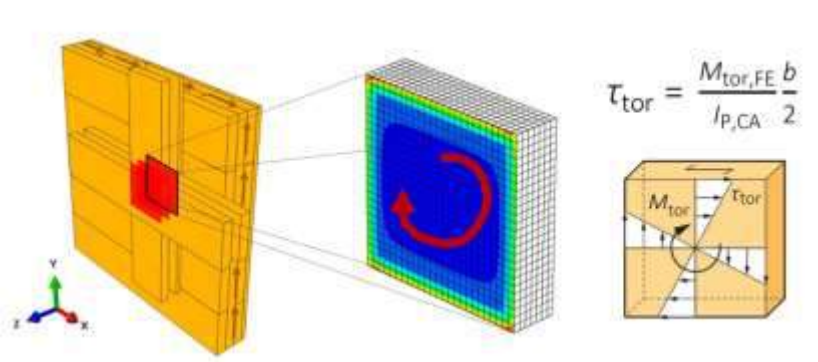


**Figure 1:** *Shear FM III (Lund University)*

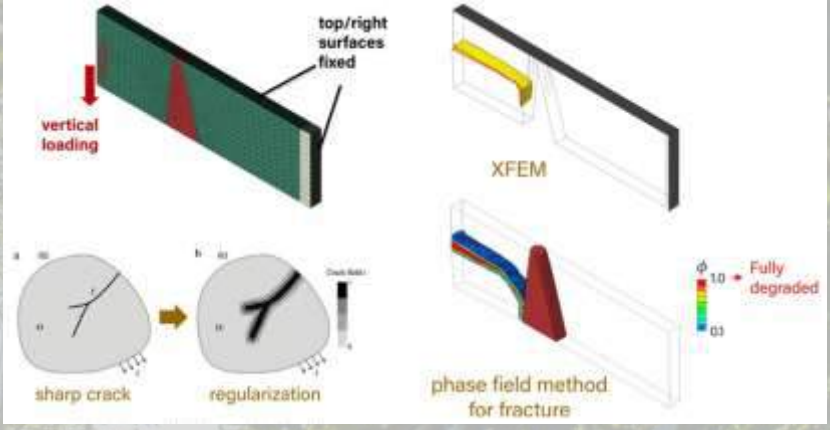


**Figure 2:** Phase field method for fracture (TUW)

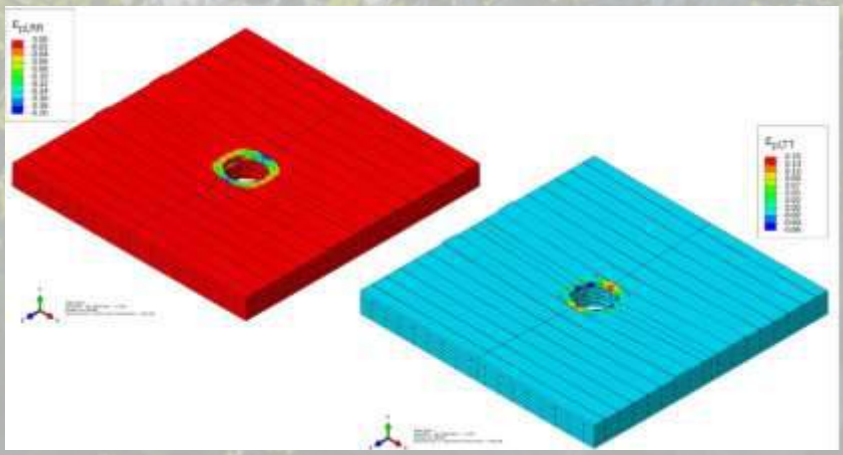

**Figure 3:** *FE modelling of point supports in CLT slabs (TUW)*

The Innocrosslam project activities in the second reporting period were - due to the covid-19 pandemic - focused more on the numerical assessment of Cross Laminated Timber (CLT) and its details (e.g. connections), however, also experimental work in laboratories was performed within the capabilities of the given situation.

WP2 (Components and Joints) research work has been focused on a model development for the assessment of load-bearing capacity of CLT in-plane shear loading conditions. Numerical studies have been performed with the aim of contributing to the development of general and rationally based modelling approaches to be used in practical engineering design situations (Fig. 1). Further development has also been accomplished regarding understanding of the mechanical behaviour of CLT plates with notches and openings. The response of CLT floors at dynamic loading has further been studied, including studies of possibilities to improve their structural low-frequency vibro-acoustic performance by using various soft- and hardwood species.

To obtain effective strength properties of knot sections in wooden boards, a new finite element code that allows the use of the phase field method for fracture (Fig. 2) was developed under WP3 (Structural performance accessed by computational mechanics). The proposed code for FE simulations enables the full 3D description of quasi-brittle failure mechanisms and orthotropic material properties found in wood.



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# INNOVATIVE SOLUTIONS FOR CROSS LAMINATED TIMBER STRUCTURES

inno cross lam



Further on, a new modelling concept for mass timber products (e.g. CLT), which includes the definition of sections with effective material properties and uses advanced fracture mechanics simulation methods, was used on common structural timber engineering details. With this approach, realistic load-bearing capacities and failure mechanisms of point-supported CLT plates (Fig. 3) were reproduced and were in good agreement with experiments previously performed at ETH Zürich.

One part of experimental investigation has been carried out within WP4 (Seismic behaviour), where brittle failures of CLT connections were tested (Fig. 4). Around 80 specimens were examined, varied in CLT type, screw length, orientation of the outer CLT laminations and other. The experimental results will be further used for theC evaluation of the analytical model of brittle connection failure. In parallel, different modelling strategies were compared for typical CLT connections and how they can be implemented for (non-)linear seismic analysis in commercially available structural design software.

**Figure 4:** *Experimental investigation of brittle failure in CLT connections (ZAG)*

The objective of the research in WP5 (Innovative multifunctional CLT) is to further develop a previously suggested CLT element, multifunctional in terms of its thermal activation, towards maturity for application. Therefore extensive series of mechanical testing (in-plane shear, buckling, torsion) on six different series of multifunctional CLT elements were carried out over the last year. Additional climatic long-term experiments were carried out in a climate chamber (Fig. 5) and secondly by numerical simulations, to investigate the deformation behaviour of the thermally activated CLT under moisture change and the cracking of its front layer.

Finally, in the last work package (WP6 – Structural Design), where the knowledge is transferred from research to practice, the work was focused on the state of the art of the modelling approaches for CLT buildings. Particular focus was given on identifying the diversity of methods and design principles used by designers in the daily practice, and their level of familiarity with the existing scientific approaches. Joint academia/industry working groups have been created, in order to have a shared space for discussion and collaboration between research partners and practitioners. With their feedback and orientation, WP6 is working on providing practice-oriented documents that will include design examples and guidance on the different modelling strategies for the identified challenging CLT design situations.

**Figure 5:** *Multifunctional CLT elements under climatic testing in the climate chamber (TUM)*

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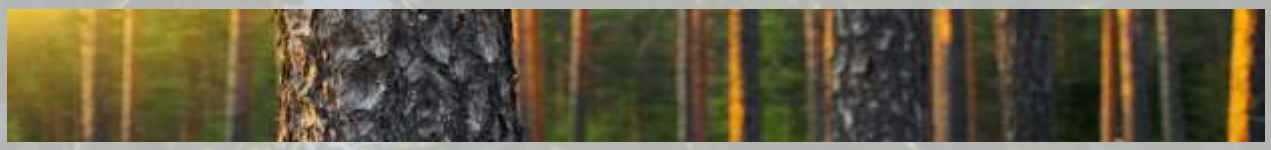

# Save the date for

# ForestValue Conference 23-25 February 2022, Skellefteå, Sweden

The conference will be jointly organised by the Swedish representatives of the following ForestValue ERA-Net Cofund research projects:

**Delivering fingertip knowledge to enable service life performance specification of wood**
*Project Coordinator: ED Suttie, BRE (UK)*
*Coordinator in Sweden: Eva Frühwald Hansson, LU*

**Dynamic response of tall timber buildings under service load**
*Project Coordinator & Coordinator in Sweden:*
*Marie Johansson, RISE*

**Improved fire design of engineered wood systems in buildings**
*Project Coordinator: Tian Li , RISE Fire Research (NO)*
*Coordinator in Sweden: Alar Just, RISE*

**Innovative joints in hardwoods**
*Project Coordinator: Carmen Sandhaas, KIT (DE)*
*Coordinator in Sweden: Thomas Bader, LNU*

**Innovative design for the future – Use and reuse of wood (building) components**
*Project Coordinator & Coordinator in Sweden:*
*Karin Sandberg, RISE*

**Innovative solutions for cross laminated timber structures**
*Project Coordinator: Boris Azinović, ZAG (SI)*
*Coordinator in Sweden: Henrik Danielsson, LU*

**READiStrength - Resource efficient and data driven integrated log and board strength grading**
*Project Coordinator & Coordinator in Sweden:*
*Olof Broman, LTU*

**INVITATION TO FOLLOW**

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## About the programme

The programme will start on Tuesday 22nd February with a pre-conference tour and a get-together in the evening.

Wednesday 23rd February will be dedicated to the projects' own meetings, and the day will end with a presentation and tour of the Sara Cultural centre (see below) and a dinner.

Thursday 24th (full day) and Friday 25th February (until noon) will be the conference days, 5 sessions held on Thursday and the remaining 2 sessions on Friday.

## Conference venue

**The conference will be held at the Sara Cultural centre** (Sara Kulturhus) right at the heart of Skellefteå, Sweden. Sara Cultural centre is currently taking form, and after it's grand opening the **8th of September 2021** it will be one of the tallest timber buildings in the world. Including a new premium 20-storey hotel, this building will become Skellefteås new hub for art, concerts, shows, meetings and congresses. The 80 metres high building is built with CLT and material from local forests. Solar cells and efficient energy use further contribute to reducing the house's climate footprint.

For more information on Sara Kulturhus, please see the website:
https://www.visitskelleftea.se/en/sara/


*Photo: White architects*

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# UPCOMING EVENTS IN THE FOREST-BASED SECTOR

21st Conference for Wood Energy

Fachkongress Holzenergie

21. FACHKONGRESS FÜR HOLZENERGIE
20. – 23.09.2021 | Digitale Veranstaltungsreihe mit 12 Sessions

20 - 23 SEPTEMBER 2021

https://www.fachkongress-holzenergie.de/en

Commonwealth Forestry Conference in Vancouver - Canada

20th Commonwealth Forestry Conference

16 - 19 August 2021

https://cfc2021.ubc.ca/

International Wood Construction Forum

15 - 17 July 2021

FORUM BOIS CONSTRUCTION FRANCE

https://www.forum-boisconstruction.com/index_E.php

**6 - 8 July 2021**

**Treescapes 2021**


https://www.birmingham.ac.uk/facilities/mds-cpd/conferences/forest/index.aspx

**20 - 24 September 2021**

**IUFRO conference - Biological Invasions in Forests: Trade, Ecology and Management (hosted by CULS)**

https://iufro.czu.cz/en

european bioplastics
Driving the evolution of plastics

16th European Bioplastics Conference

30 November – 1 December 2021

https://www.european-bioplastics.org/events/eubp-conference/

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**23 - 24 September 2021**

**Forum Wood Building Nordic (WBN)**

https://lnu.se/en/meet-linnaeus-university/current/events/2021/forum-wood-building-nordic-2021/

**8 - 10 September 2021 # ERSCP European Roundtable on Sustainable Consumption and Production**

**13 - 15 September 2021 # Annual WCEFonline event -The World Circular Economy Forum**

**13 - 15 September 2021 # 9th World Sustainability Forum**

**22 - 24 September 2021 # Natural Resources, Green Technology and Sustainable Developement/4 -GREEN2020**

**13 - 15 October 2021 # International Conference on Wood Adhesives**

**14 - 15 October 2021 # International Softwood Conference (ISC 2021)**

**15 - 19 October 2021 # Woodrise Conference Japan**

**1 - 12 November 2021 # 2020 UN Climate Change Conference (COP 26)**

**3 - 4 November 2021 # Building Green Copenhagen 2021**

**17 - 18 November2021 # Building Green Hamburg**

## Imprint

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privacy policy: **20180803_forestvalue_privacy_policy_v1.0.pdf**

For questions, inquiries or feedback, please send an email to: **call.office@forestvalue.org**

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