Part B Project description

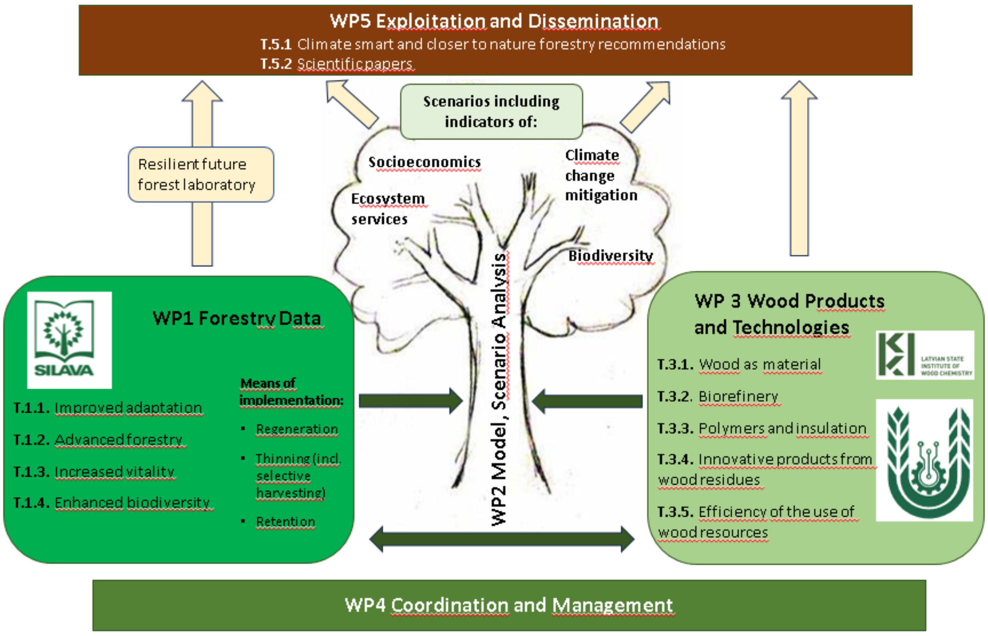
Project title: **Innovation in Forest Management and Value Chain for Latvia's Growth: New Forest Services, Products and Technologies (Forest4LV)**

1. Scientific excellence

1.1. Contribution to the overarching objective and objective of the programme and to the implementation of the thematic tasks

Forest4LV aims to **enhance innovative forest management and new forest services, products and technologies** in Latvia. The overarching objective of **Forest4LV** is to facilitate the use of natural resources sustainably and rationally, increasing their added value in a changing environment, while the sub-programs (work packages - WP) aims at ensuring the sustainability of forestry and the rational use of Latvia's forest resources to produce globally competitive products while preserving biodiversity and the social importance of forests for future generations.

To achieve these objectives, essential components are 1) sound policies and 2) innovative technologies and products. Sound policies are based on accurate scenario modelling, which will be the core of the project, harbouring generated indicators of socioeconomics, biodiversity, ecosystem services and climate change mitigation as inputs of the long-term projections of effects of changes in forest management. Given the limitations of time and scale of the project, all the input data to calculate the outputs cannot be collected, therefore knowledge gap analysis will be performed, based on the competence in leading forest research organizations in Latvia – Latvian State Forest Research Institute "Silava" (**Silava**) and identifying the needs of additional data in each of the categories (survival, growth, quality, indicators of biological diversity, adaptation) to model the effects of potential changes in regeneration, thinning (including selective harvest) and retention (Task 1.2. WP1) and their effects on other ecosystem services.



Scenario modelling (WP2) will be based on existing algorithms – growth models, which include climate-change and disturbance effects – based on National forest inventory (NFI) data and improved understanding on interlinkage between calculated stand parameters and required output values. Socioeconomic effects in such modelling will be comprehensively assessed via analysis of the information on forest products (and their potential changes), provided by leading institutions in this sphere in Latvia: Latvian State Institute of Wood Chemistry (**LSIWC**) and Latvia University of Life Sciences and Technologies (**LBTU**). These institutions will also ensure the development and testing of new products, envisioned in the objective of the WP3. Synergy between forestry experiments (WP1) and assessment of wood properties form these experiments (WP3) will be benefit the practical plausibility of the scenarios (WP2). Also, the cooperation between the forest and wood processing research will provide new knowledge for more accurate assessment of substitution effect and hence climate change mitigation effect of the forest sector, which is currently being widely debated[1]. Such information in models is crucial, since forest sector is increasingly influenced by market changes with the

[1] Kallio A.M.I., et.al. *Environmental and Climate Technologies*. **2023**, *27(1)*, doi: 10.2478/rtuect-2023-0020

rising share of green investment (due to demands of consumers and shareholders, and regulations on the establishment of a framework to facilitate sustainable investment according to Regulation (EU) 2020/852) requiring development of innovative materials from renewable resources with substantial life span and/or potential to recycle. Impact of decision making at the level of European Union (EU) is considered: the planned results will ensure 1) better adaptation of very recent changes in EU legislative acts at national level, and 2) relevant input for further policy development at EU level.

The WP3 of the **Forest4LV** will most directly address the tasks mentioned in the EU *Biorefinery outlook to 2030*, that is, a circular bio-based economy is seen as an important element of a European low carbon economy, and is expected to increasingly contribute to greenhouse gas (GHG) flux emission reductions, decreased dependence on fossil resources and drive economic growth over the next decades. An example of a wood construction-promoting policy can be found in Nordic countries, where a strong focus on a minimal carbon footprint from construction also indirectly boosts the use of wood-based materials. Achieving the scale up of new bio-based chemicals and materials production capacity is challenging, because of the level of investment required in plants, coupled with technology and market risk hindering financing.

The additional indicators, used in scenarios to characterize biodiversity and climate change mitigation, will be helpful to improve the understanding on how the Regulation of the European Parliament and of the Council on nature restoration (adapted by European Council in 17th of June, 2024) could be better implemented. The planned results will also improve the understanding on implication of Closer-to-Nature Forest Management measures and EU forest strategy for 2030.

To ensure the integration in research processes at the European scale, and to cover both demonstration and further research needs, Resilient Future Forests Laboratory (RFFL) will be established in Research Forests, in cooperation with the developers of this concept from IUFRO (support letter attached). It will consist of two parts: 1) compilation of subset of existing experiments and plots in mixed stands, data from which will be gathered and used in project (WP1); and 2) plan for establishment of new trials based on results of the analysis (WP1 and WP2). RFFL will be developed in the coordination with IUFRO Task Force on Living Labs, announced at the World Congress in June 2024. Task of establishment of new trials, not possible in project timeframe, will be taken over by Research Forests and supervised by the leader of the WP1, with the time costs covered by base funding for scientific work, thus ensuring the continuity and sustainability of the project outputs.

The assessment of aspects of adaptation will be conducted in cooperation with and announced *via* EFI Climate Smart Forestry (CSF) network (support letter attached). Sites, where complex interaction (regeneration material (genetics) x method x thinning intensity; thinning intensity x regeneration material (genetics) x soil improvement) can be evaluated, will be used to draw novel regional knowledge, relevant for CSF. Results from the experiments in planted stands (with emphasize on approaches to enhance biodiversity and ensure outcome of wood, suitable for novel products) will be shared with European Institute of Planted Forest to facilitate recognition of the project and to develop common further research projects (support letter attached).

In accordance to the tasks, defined in the **Forest4LV** WPs, Scots pine will be the main model tree species in WP1, given its capacity to resist natural disturbances, such as intensifying wind events and meteorological extremes, as well as abundance in areas, where timber productions is not the primary objective – thus where suitable multifunctional forestry approaches are needed. Economic importance, yet projected reduction in abundance of the species within the region necessitates the development of novel management approaches to compensate and mitigate the adverse trend. In WP3 also other tree species (birch, aspen and alder) will be addressed, though primarily from mixtures and in relation to development of new wood products from several wood processing residues.

1.2. Project goal, hypothesis, objectives, current situation (know-how) in the field of science

The goal of the Forest4LV is development of holistic approach to ensure sustainability of forestry and the rational use of Latvia's forest resources to produce globally competitive products while preserving biodiversity and the social importance of forests for future generations.

Objective of the WP1 is development of forest management practices, improving forest productivity and capacity to play a long-term role in climate change mitigation, enhancing the integration of biodiversity values and facilitating the production of a spectrum of forest ecosystem products and services in a changing environment. All of the activities, defined in regulation of the call, are covered, as shown in the section 3.2. Project activity plan (Tab.2). They are grouped according to four tasks, and characterized through the means of implementation in forestry practice: **regeneration, thinning, and retention**. Uniform collection of data of several categories – **survival, growth, quality, indicators of biological diversity, adaptation** – will be carried out to ensure integrity of tasks and activities. The category "quality" is considered as branch traits and suitability wood for novel materials, ensuring interdisciplinarity of research (connection to WP3) and scientific novelty. “Biological diversity” refers to genetic diversity (if specifically noted), diversity ground vegetation and epiphytes and epiksyles (indicating the management effect and returning stability of forest environment[2,3]) and, in older stands, also tree related microhabitats[4] (TRM), assessed in relation to treatment, where such information is missing, and ensuring scientific novelty. “Adaptation” refers to characterization of adaptability in terms of climate sensitivity (including response to weather extremes) of trees via quantitative genetics, based 2024), yet only few studies have used this innovative approach so far in the region[5,6], none of them assessed larger number of genotypes from local populations. Thus, novel understanding will be created in this respect, applying methodology, approbated by the project team[8].

Emphasis will be put on trials, where interactions between treatments can be comprehensively and explicitly assessed, filling the knowledge gaps (in the section 3.2. Project activity plan). Also, specifics of growing conditions, affecting pine forests, due to hydrology in Baltic artesian basin (considerable contribution of discharge waters to runoff[7]), will be considered, ensuring novel data with high regional relevance.

T.1.1. Improved adaptation. Detailed information on genotype-environment (GxE) interaction and heritability estimates for growth sensitivity traits will be obtained and used to improve the overall knowledge on adaptive capacity with implications in practical tree breeding program (methods, material) and forestry. Additional insights in GxE interactions will be gained by analysis of realized genetic gain trials[8], where interaction between genetic properties and regeneration method and thinning intensity can be quantified. For better understanding of practical implementation of the **TRIAD principle** for biodiversity conservation[9], effect of use of different genotypes at varying shares at forest landscape on genetic diversity will be analysed.

T.1.2. Advanced forestry. Thinning effect of different genotypes has been scarcely studied in the Baltic Sea region[10], currently neglecting thinning intensity and biodiversity indicators. Thus, the knowledge gained will be valuable at European scale to advance **Climate-Smart Forestry** (CSF) approach. Closer-to-Nature (CTN) forestry measures will be addressed from a perspective of probability of successful regeneration (basis of decision making in adaptive management), while maintaining biodiversity, including advances in understanding of veteran trees and related microhabitats. The explicit positive effect of hidromelioration on growth are well documented, however, there is still scarce ecological reasoning for the frequency of maintenance of drainage systems[11] particularly considering specifics of Baltic artesian basin, and in connection to thinning. Groundwater maps[12], and advances in soil mapping[13] (recently developed in **Silava**), linked with information on growth (LIDAR data) and species diversity (sample plots) will be used of afforestation recommendations for Scots pine.

T.1.3. Increased vitality. Increasing pressure of natural disturbances[14] requires novel knowledge on mid-term (10-15 years) survival of affected trees for post disturbance decision making to ensure vitality of stands. Increased vitality often can be achieved by mixed stands[15,16]. However, admixture and thinning effects on browsing damages and insect-pathogen interaction effects, which are poorly understood, will be assessed, based on experimental sites.

T.1.4. Enhanced biodiversity. Efficiency of measures intended to enhance biodiversity in managed forests, will be assessed based on survival of retained trees, as well as capacity of them and wet patches to maintain functional diversity[17,18]. Presence of well-studied, pine-forest related model species *Odontoschisma denudatum* L. witch has been linked to stable forest microenvironment and deadwood, will be used as a proxy. Research

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[3] Hauck, M., et. al. *Biol. Conserv*. **2013**, *157*, doi: 10.1016/j.biocon.2012.06.015.
[4] Bütler, R., et. al. Field Guide to Tree-related Microhabitats. Descriptions and size limits for their inventory. Birmensdorf, Swiss Federal Institute for Forest, Snow and Landscape Research WSL. **2020**, 59 p, Technical Report.
[5] Matisons, R. et al. *Forests*, **2021**, *12(8)*, doi: 10.3390/f12081101.
[6] Matisons, R., et al. *Dendrochronologia*, **2024**, *85*,doi: 10.1016/j.dendro.2024.126187.
[7] Virbulis, J., et. al. *Hydrogeology Journal*, **2013**, doi: 10.1007/s10040-013-0970-7.
[8] Haapanen, M. *Silva Fennica*, **2024**, *58(1)*, doi: 10.14214/sf.23072.
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[10] Gailis, A., et. al. *Forests*, **2020**, *11*, doi: 10.3390/f11030327.
[11] Sikström U., et. al. *Sci. Rep.*, **2019**, doi: 10.1080/02827581.2019.1705891.
[12] Ivanovs, J., et. al. *Water Management*, **2020**, doi: 10.22616/rrd.26.2020.036.
[13] Ivanovs, J., et. al. *Land*, **2024**, *13(4)*, doi: 10.3390/land13040466.
[14] Patacca, M., et. al. *Global Change Biology*, **2023,** *29(5)*, doi: 10.1111/gcb.16531.
[15] Jactel, H., et. al. *Current Forestry Reports*, **2017**, *3(3)*, doi: 10.1007/s40725-017-0064-1.
[16] Jactel, H., et. al. *Annual Review of Entomology*, **2021**, *66*, doi: 10.1146/annurev-ento-041720-075234.
[17] Gustafsson, L., et. al. *BioScience*, **2012**, *62(7)*, doi: 10.1525/bio.2012.62.7.6.
[18] Gustafsson, L., et. al. *Ecological processes*, **2020**, *9(1)*, doi: 10.1186/s13717-019-0208-2.

group has approbated field inventory and data analysis methods in the pilot study[19]. Overall effect of forestry on deadwood, admixture, and tree related microhabitat characteristics in relation to management and stand age will be quantified, based on NFI data.

The objective of the WP2 is to analyze and develop recommendations on the socio-economic aspects of forestry, including public benefits, for the advancement of multi-purpose forest management, new forest services, products and technologies. It will be achieved, by combining the data and findings of WP1 and WP3, advancing the assessment of set of pre-selected indicators and scenario modelling system (SMS). Additional indicators, important for forest sector enterprises and state in the context of implementation of EU Regulation 2020/852 (on the establishment of a framework to facilitate sustainable investment) and Directive 2022/2464 (on the corporate sustainability reporting), will be elaborated and incorporated in the SMS. The obtained results will be suggested for recommendations for development of policy and practice. The SMS will contribute to different policy needs including improvement of methodology for greenhouse gas flux (GHG) reporting and development of projections within the scope of UNFCCC, Paris agreement and related national and regional policies, implementation of sustainability criteria set in the Directive (EU) 2023/2413, restoration indicators, as set in the Regulation on nature restoration and other policies.

The SMS will be based on inhouse built, stand-based forest growth and yield modelling tool, which currently allows to account for effect of natural disturbances, primarily wind (locally adjusted Forest Gales coefficients) and biotic agents, as well as effects of mean precipitation and temperature changes. It has been calibrated on NFI data (re-measured sample plots), and validated on historic data[20], and is suitable for pure and mixed multicohort stands. This modelling tool will be further elaborated by integration of additional effects of adaptation, growth, and tree vitality (non-lethal damage) (WP1).

To advance economic assessment in the modelling tool, currently implemented via empirical equations of assortment outcome[21], the effect of management methods (WP1) and their interlinkage with suitability for new wood products (WP3) will be supplanted into the system. Currently climate change mitigation effect has been estimated, based on soil (suitable for the region of Baltic artesian basin), biomass and assortment outcome, neglecting substitution effect. To increase the accuracy of this assessment in relation to proposed changes forest management, current tool will be supplemented with **substitution effect**, which will be derived from analysis of product life cycle (WP3) thus complying with the holistic approach.

Substitution effect allows to account for circulation of carbon between biosphere and atmosphere, if wood products are used, instead of release of carbon sequestered over millions of years, while using fossil materials[22]. The substitution effect will be estimated according to the guidelines for ICP Forests process. According to this approach, challenges addressed in the project, will be: 1) association of assortment structure with the structure of harvested wood products (HWP) and forest biofuel; 2) evaluation of currently non-accounted CO_2 removals in HWP produced from exported industrial roundwood, depending from the export destination; 3) quantification of product-specific half-life and after-life decomposition for innovative wood products for implementation in the national GHG inventory.

Principal ecosystem service (ES) will be evaluated based on the cascade model[23] of the International Classification of Ecosystem Services (CICES, V5.1.) for international compatibility[24,25]. The long-term effects of forest management on the principal ES: timber, energy wood and forest berry yields in the provisioning services, carbon sequestration in the regulation and maintenance services, recreational value (passive and active recreation) in the cultural services, will be allometrically included in the SMS[26] , accounting for the outputs of WP1. Algorithms for the indicator calculation developed in previous projects[27,28,29,30,31] will be complemented by the attributes tailored to reflect closer-to-nature forestry approaches in pine-dominated

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[19] Mezaka, A., et al., *Nova Hedwiga*, **2022**, *115(1-2)*, doi: 10.1127/nova_hedwigia/2022/0708.
[20] Lazdins, A., et. al. *LSFRI Silava*, **2019**, doi: 10.13140/RG.2.2.24760.70406.
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[22] Kallio, A.M.I., et. al. *Environmental and Climate Technologies*, **2023**, *27(1)*, doi: 10.2478/rtuect-2023-0020.
(due date reported in respective WP)
[23] Zhang, C., et. al. *Ecological Indicators*, **2022**, *137*, doi: 10.1016/j.ecolind.2022.108766.
[24] Potschin, M. B., et. al. *PPG: Earth and Environment*, **2011**, *35(5)*, doi: 10.1177/0309133311423172.
[25] https://cices.eu/
[26] Jurmalis, E., et. al. *Land*, **2023**, *12(10)*, doi: 10.3390/land12101836.
[27] Donis, J., et. al. *LSFRI Silava*, **2008**. Development of clear-cut forest management model. Research Report.
[28] Donis, J., et. al. *LSFRI Silava*, **2013**. Evaluation of the economic activity in the selected logging farm. Research Report.
[29] Jurmalis, E., et. al. *Acta Biol. Univ. Daugavp*, **2017**, *17(1)*, ISSN: 1407–8953.
[30] Libiete, Z., et. al. *LSFRI Silava*, **2020**. Impact of forestry on forest and related ecosystem services. Research Report.
[31] Saklaurs, M., et. al. *Forests*, **2022**, *13(6)*, doi: 10.3390/f13060928.

forests (WP1). These will be indicators, such as stand structural complexity, deadwood (by type and dimensions), species functional richness/diversity and tree-related microhabitats, linked to management approach and stand parameters. The SMS will be used for scenario analysis applying methods of social impact assessments[32,33] to derive policy recommendations.

Objective of the WP3 is the development of innovative technologies and products for using local forest resources to produce competitive and sustainable products, promoting the rational use of wood, developing wood construction in line with the European Green Deal (EGD) and contributing to the circular forest bio-economy. All of the tasks and activities, defined in regulation of the call, are shown in the section 3.2. Project Activity plan. They are grouped according to five tasks, and characterized through the means of implementation in wood processing practice: **wood as material, biorefinery, biobased polymers and insulation, innovative products from wood residues and efficiency of the use of wood resources**. Uniform collection of data of several categories – **yields, technological properties, substitution rate, application, product life cycle, CO2 emissions and scalability** – will be carried out to ensure the information for WP2.

T.3.1. Wood as material. As forest structure in Latvia has very fragmented several wood species, most common must be chosen to expand wood-based materials in construction in line with the EDG. Thus, rationalising the resources and widening the use of wood materials in construction and living environment, improving or maintaining the performance of the material/product. This corresponds to the aim of the program – the development of wooden construction following EGD guidelines on prioritizing the use of renewable resources. To solve the set tasks the evaluation of **juvenile wood (JW)** in glued wood products, as well as improvement of plywood weathering properties will be investigated. The studies on the formation of JW, its anatomical and physical characteristics have shown that certain parameters of JW differ substantially from those of mature wood[34]. In the activity **A.3.1.1.** JW of pine (*Pinus sylvestris* L.) and birch (*Betula* spp.) will be investigated focusing on the technological possibilities of its use. The data on the quantitative composition of currently obtained JW (extractives, phenolic derivatives etc.) will in turn serve as a reference for further assessment of climate change on JW technological properties and development of growth models.

A.3.1.2. Wood has numerous disadvantages, including excessive moisture and water uptake, poor dimensional and weathering stability, low biological durability, poor fire resistance and a soft surface. Wood modification can overcome these drawbacks[35]. Several **wood thermal treatment methods will be evaluated** to obtain plywood from modified veneers – **nitrogen and vacuum atmosphere**. Thermal treatment in nitrogen atmosphere of birch (*Betula pendula*) and pine (*Pinus sylvestris*) wood in comparison with aspen (*Populus tremula*) and black alder (*Alnus glutinosa*) will be carried out in **LSIWC**. While in **LBTU** will use birch (*Betula pendula* Roth.), aspen (*Populus tremula* L.) and poplar (*Populus x canadensis* Moench.) veneers by vacuum treatment method in cooperation with partner - Italian Institute of BioEconomy – IBE[36]. Physical and mechanical properties, biological durability and weathering performance of the innovative plywood products will be evaluated in **LSIWC** and **LBTU**. Investigation of the several thermal treatment modes will be used to evaluate glue-ability of processed veneers with several adhesives, especially **environmental friendly suberinic acid binder** developed and patented by **LSIWC**[37].

T.3.2. Biorefinery. Today, one of the pillars of EU policy is focused on the efficient transformation of biomass into products **capable to substitute petroleum derivatives**, thereby aiming for a competitive and climate-neutral economy. To integrate forestry and wood processing residues as a feedstock in sustainable biorefining technologies to obtain high added value products, several processes will be investigated: **A.3.2.1.** Pretreatment technology of plywood residues to obtain such **platform chemical as 5-hydroxymethylfurfural[38]; A.3.2.2.** Processing of birch and pine barks into **catechol-moiety bearing extractives[39],** as well as **A.3.2.3.** Pine wood sawdust (filler) and ecological binder (from birch bark) to obtain **ecological wood-based composites[40]**. Thus, all types of woody by-products are covered: 1) hardwood forestry or plywood residues (birch as reference material); 2) bark of common wood species and 3) wood sawdust after sawing and/or cellular wood material (CWM) production where more than 40% of the log is generated as by-product for further processing. Several pine barks in **A.3.2.2.** obtained from **Silava** with different forestry management approaches will be tested.

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[32] Costanza, R., et. al. *Global Environmental Change*, **2014**, *26*, doi: 10.1016/j.gloenvcha.2014.04.002.
[33] Imbrenda, V, et. al. *Sustainability*, **2023**, *15*, doi: 10.3390/ su151310271.
[34] Li, M., et. al. *Journal of Wood* Science, **2021**, *67(1)*, doi: 10.1186/s10086-021-01992-6.
[35] Grinins, J., et. al. *Materials*, **2024**, *17(7)*, doi: 10.3390/ma17071468.
[36] Meija-Feldmane, A., et. al. *BioRes*, **2020**, *15(2)*, doi: 10.15376/biores.15.2.4150-4164.
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[39] Das, A. K., et. al. *South African Journal of Botany*, **2020**, *135*, doi: 10.1016/j.sajb.2020.08.008.
[40] Tupciauskas, R., et. al. *European Polymer Journal*, **2019**, *113*, doi: 10.1016/j.eurpolymj.2019.01.061.

Thus, **LSIWC together with Silava** will investigate the potential of forestry approaches to add the value of biorefining products.

T.3.3. Biobased polymers and insulation. According to statistical data, a lot of residues and waste were formed in forestry industries every year, specifically, sawdust, bark, non-conditional wood, needles, etc. Therefore, several wood processing residues were used to obtain bio-based polymer composites and insulation materials: bark extraction residues from **A.3.2.2.**; wood mechanical processing residues from *T.3.5*, as well as pulp production residue from pine wood (tall oil). These residues will be investigated to obtain several polymer products for insulation (**A.3.3.1. and A.3.3.2. - bio-based rigid polyurethane foams**[41,42]**)** and for increasingly popular interior materials (**A.3.3.3. - wood polymer composites**[43]**)** to increase their added value and substitute the petrochemical part with biobased compounds contributing to environmental issues such as carbon emissions and resource depletion. Thus, wood processing residues will be incorporated into biobased polymers and insulation materials to respond to the Circular economy requirements.

T.3.4. Innovative products from wood residues. Finding of original solution is very important because collaboration in different research fields can ensure products with higher added value. Two completely different research fields using different wood processing residues will be investigated in the task: **A.3.4.1. -** Densification of chemically pretreated wood into the **osteosynthesis implant material** (medicine) using plywood production residue – veneer core – as a feedstock[44]; and **A.3.4.2.** biotechnology approach for development of **forest biological control agent** (forestry) using pine mechanical processing residues as a feedstock[45]). In the **A.3.4.1.** a new wood modification approach will be developed to obtain densified and shape-stable pre-delignified hardwood materials (veneer peeling cores) for osteosynthesis implant to eliminate the disadvantages of common products. While in the **A.3.4.2. LSIWC** together with **Silava** will investigate *P. gigantea* spore production on sawmills pine residues from *T.3.5.* in order to use the spores of the fungus in forestry practices to reduce root and butt rot caused by the fungus *Heterobasidion* in coniferous stands.

T.3.5. Efficiency of the use of wood resources. The invention of the cellular wood material (CWM) Dendrolight is considered one of the few innovations in the wood processing industry of the last decades[46]). Stabilized lightweight blockboard (SLB) is a patented solution for increasing the efficiency of the use of wood resources with elements of smart technology solutions[47]. Currently, neither CWM (**A.3.5.1.)** nor SLB (**A.3.5.2.)** is available on the market, there is a lack of detailed and comprehensive information about the properties, so that potential manufacturers can create a declaration of product conformity. From the already realized studies on the CWM properties (specific gravity or relation between mass and strength properties, physical-mechanical etc.), that smart technologies should be developed for the technological solutions of production and the efficiency of the use of wood resources[48]. This will make a significant contribution to increase the accuracy of the manufactured products – dimensional stable components, considering that the mentioned products will be used for elements of furniture and in construction. In addition, the residues from the production of the CWM from pine wood (46% of total mass[49]) will be investigated as a feedstock in **A.3.2.3., A.3.3.3.** and **A.3.4.2.** to increase their added value. Also, these materials will be tested in combination with ecological particle boards from **A.3.2.3,** wood polymer composites from **A.3.3.3.**, as well as plywood from thermally treated veneers from **A.3.1.2** and **A.3.1.3.**

1.3. Project implementation model and the role of cooperation partners in achieving the project's aim and objectives and mutual complementarity

The project partners have a long cooperation track record. In 2014, the members of this consortium collaboratively established the Bioeconomy Strategic Research Alliance, uniting all the key research institutions with strategic specializations in bioeconomy sectors in Latvia, aiming for closer collaboration. Since then, these institutions have successfully worked together on numerous projects, including various research initiatives, joint infrastructure investment projects, and collaborations with businesses, such as the 'Business Vouchers' or in the projects coordinated by the Forest Development Found and/or the Forest Sector Competence Centre of Latvia. Within the project, each consortium member has a distinctive specialization,

[41] Ivdre, A., et. al. *Polymers*, **2024**, *16(7)*, doi: 10.3390/polym16070942.
[42] Salim, R. M., et.al. *Wood Science and Technology*, **2021**, *55*, doi: 10.1007/s00226-020-01258-2.
[43] Shulga, G., et. al. *Cellulose Chem. Technol.*, **2019**, *53(9-10)*.
[44] Andze, L., et. al. *Materials Science Forum*, **2022**, *1071*, doi: 10.4028/p-r57u45.
[45] Allen, B., et. al. *Silva Fennica*, **2022**, *56(2)*, doi: 10.14214/sf.10606.
[46] Labans, E., et. al. *Civil-Comp Proceedings*, **2012**, doi: 10.4203/ccp.100.104.
[47] Rozins, R., et. al. Patent LV14929B, **2014**.
[48] Iejavs, J., et. al. *Drewno*, **2016**, *59(198)*, doi: 10.12841/wood.1644-3985.156.14.
[49] Rozins, R., et. al. *Forestry and Wood Processing*, **2014**, *2*.

complementing each other perfectly. Forestry-related topics and biodiversity, are covered by **Silava**. **LSIWC** focuses on wood as construction material, wood chemical processing and biorefinery. **LBTU** deals with wood mechanical processing. Research teams in each WP are formed by researchers from various research disciplines. Project will be led by **LSIWC**. All project coordination and management activities are described in WP4.

2. Impact

2.1. The impact of the project and its results on the fields of natural sciences, engineering and technology and forestry science and the development of their research community in Latvia

Project will ensure substantial effect on the research field. The intended collaboration will facilitate deeper inter-disciplinary cooperation within the project team and involved institutions, thus strengthening their capacity to develop larger national and international projects in the future. Those are envisioned to focus on the developed model and approaches, supplementing new knowledge (e.g., on biodiversity indicators, development of renewable materials, or improved approaches in recycling of materials) accounting for extended spectrum of scenarios, thus better meeting the complexity of human-environment interactions and effects on forest ecosystems in the changing world.

During the project, an **interdisciplinary** groups of scientists from **LSIWC**, **Silava and LBTU** will be created. On the basis of knowledge from the interdisciplinary group, the processing of biomass from a diverse perspective will be possible, thus increasing the potential of the human capital and **research capacity** for the further development and testing of innovative bio-based products. In turn, the planned interdisciplinarity of the project (forestry, chemistry, materials science, biology, biotechnology etc.) and results will promote collaboration of the scientific institutions and industry, as well as will contribute to international recognition of scientific achievements.

The results of the research project will act as a tool for more comprehensive evaluation of the regional and local impacts of the proposed changes in EU legislation, thus aiding development of more plastic and regionally adjusted policy proposals for efficient adaptation of forest related sectors of economy at multiple scales. This complies with the concepts proposed in the IUFRO2024 world congress regarding the dismissing one-size-fits-all principle in legislation. For example, this implies evolving ways of application of Taxonomy directive and paradigms of biodiversity protection.

The implementation of the intended research project will also strengthen the existing and facilitate development of new **international cooperation**, via inclusion of its results in international networks, as described in section 1.1. Also, it is intended to give presentations in COST actions (CA19128, CA20132, CA22142, CA23148) and Nordic Forest Research cooperation network (including also Baltic states) e.g. PROFOR, as well as other similar arenas, increasing international impact of the obtained results and thus opening new possibilities to develop joined research projects in the future. Such collaboration would directly contribute to development of applications in Horizon program (related to the solutions for soil health, assessment of multiple effect of natural disturbances at EU scale, and possibilities for climate change mitigation), as well as one application in INTERREG program, and development of a bilateral project proposal in collaboration with Linneus University on decision making on the application of Closer-to-Nature forestry methods. Additional positive cooperation effect will be gained from the intended development of multi-spectral remote sensing aiming for practical applications. The obtained data will be shared with the International Capacity Development Group on Soil Spectroscopy (SoilSpecNet) to collectively advance the field of soil IR spectroscopy. This involves collaboration with other leading laboratories in soil spectrometry worldwide.

For the involvement of local communities in circular bioeconomy and to highlight opportunities arising from the novel polices, it is intended to advance the cooperation with municipalities (local community centers and NGOs). This would facilitate rapid information exchange at the different scales, fostering development of projects, tailored for local needs i.e. for SME enterprises in niche fields.

The project will impulse completion of **PhD. for four early-carrier researchers** by providing funding and access to datasets obtained. The horizontal knowledge transfer in the form of scholarships and seminaries will facilitate dissemination of the research findings and approaches thus increasing scientific capacity and career perspectives of the PhD and other affiliated students, thus ensuring growing research capacity and diversifying viewpoints of the involved institutions and beyond them.

The developed plans for establishment of new sites to test innovative solutions for increased resilience in RFFL will be implemented in cooperation with Research Forests and will create valuable data for further advances in research. Since the development of the designs is a result of cooperation with the respective IUFRO task force, it will be internationally recognized and will include experiments spreading across several countries in different forest zones – serving as the basis for further research cooperation and new EU scale research applications for policy development.

The advanced information on species diversity (ground vegetation, epiphytes, epixyles) in the assessed sites, gained in this project, will make excellent basis for further in-depth studies on the development dynamics, as well as other issues beyond the scope of current proposal e.g. soil diversity and health, insect communities etc. which are needed to advance the understanding and protection of biodiversity, a very topical subject, that will ensure research cooperation and new projects (e.g. LIFE+) in the future.

LSIWC and **Silava** are active participants in the BIOEAST initiative (Central and Eastern European Initiative for Knowledge-based Agriculture, Forestry and Aquaculture in the Bioeconomy; https://bioeast.eu/). **LSIWC** is a partner in the Thematic Working Group (TWG) advanced Biobased Materials; **Silava** - TWG Forestry. The results of the Forest4LV project will be unique in Latvia, but they will be complementary to the studies of other Widening countries, thus creating a more complete picture of Central and Eastern European potential in the entire European context. The BIOEAST initiative has defined its strategy and readiness to be included in solving EGD tasks in the Stakeholder Manifesto (published May, 2024) on sustainable supply chains and strengthened local processing of bioresources in Central and Eastern Europe (https://bioeast.eu/wp-content/uploads/2024/05/MANIFESTO-1.pdf)

2.2. The impact of the project and its results on policy makers and implementers in planning the development and implementation of policy recommendations for sustainable and rational use of natural resources, enhancing their value in a changing environment

Quantitative assessment of adaptability and its limitations of native tree populations is highly advantageous for long-term policies regarding the forest reproductive material and adaptive management strategies contributing to the rationality of forestry and forest related sectors (rational and sustainable processing of wood materials and their production residues) economy. Enhancement of sustainability of forest regeneration material and its coherence across environmental gradients is paramount for the multifunctionality, as well as commercial, economic, social, and nature conservation values of forests. The outputs of comprehensive local/sub-regional models for sustaining and improving forest multifunctionality is also advantageous for finetuning the regulation at regional (e.g., EU) level, thus contributing to inclusiveness of policies and principles of national self-determination. As a result of **Forest4LV** nine recommendations will be developed (see section 3.2. Project activity plan) for both, policy makers (four recommendations) and local industry sectors (five recommendations) that will help implementers to plan and develop national policy recommendations for sustainable and rational use of natural resources, enhancing their value in a changing environment.

The elaborated modelling system developed will contribute to improvement of reporting and projections of the GHG emissions (UNFCCC, Paris Agreement and Regulation (EU) 2018/841 related reporting documents), evaluation of conformity to sustainability criteria according to Directive (EU) 2023/2413 and Implementing Regulation (EU) 2022/996 and forest value and carbon stock change modelling within the scope of sustainability reporting as requested in the Regulation (EU) 2020/852 (Taxonomy regulation).

2.3. The impact of the project and its results on students in the education process, integrating research into the study process, using the scientific results of the project in the teaching process of higher education, as well as building the capacity of students and the scientific group

The implementation of horizontal knowledge transfer and inclusion in all stages of implementation (from designing of the research to presentation of the results and public engagement) will contribute to professional growth of the students involved in the activity. To achieve this, it will be ensured, that **all students (average in project 5.8PLE)** participate in all stages in the research effort, while allowing specialization according one's competences. This will apply to the professional staff involved, thus boosting practical and theoretical skills of the cutting-edge forestry research. For students, access to specialize and general conferences domestic and international in the relevant fields will be provided, encouraging presentation and discussion, thus increasing their recognition and improving career perspectives. Project will directly contribute to finalization of 4 PhD thesis, substantially benefitting the new generation of forest-sector researchers. Overall content of PhD studies will be improved, while organizing PhD courses – in cooperation with universities in other Baltics countries, to ensure sufficient number of participants and efficiency distribution of knowledge (letter of intent attached). Results of the program will be incorporated in the curriculum of Forestry master program, thus further contribution to education. For forestry practitioners, recommendations will be developed and distributed in cooperation with largest forest owners association (see letter of support), also regularly organizing course for their members. Additionally, life-long learning courses will be advanced in strengthened cooperation with Linnaeus University (support letter attached).

The cooperation will be used to ensure wider recognition and further professional contacts of project research team and affiliated students, and will lead to development of new European and regional scale research proposals and higher-ranking open-access publications.

2.4. The impact of the project and its results on the economy and society as a whole, ensuring the transfer of knowledge and promoting understanding of the role and contribution of research to the economy and society as a whole

Increased sustainability of forestry and forest related sectors of economy, which contribute to > 15% of the national GDPs within the region, is paramount for the society as a whole, both in financial and environmental terms. Effectiveness and sustainability of adaptive forest management and breeding in particular is therefore critical in long-term. Sustaining and contributing to the multifunctionality of forests is also essential for the social aspects, as forests play central role of people in the Baltic Sea region, with high emphasis on the cultural aspects and national self-identification. Forests are also popular for recreation, thus contribution to physical, mental, and emotional health of local societies and beyond them.

The elaborated scenario modelling system developed will contribute to improvement of reporting and projections of the GHG emissions (UNFCCC, Paris agreement and Regulation (EU) 2018/841 related reporting documents), evaluation of conformity to sustainability criteria according to Directive (EU) 2023/2413 and Implementing Regulation (EU) 2022/996 and forest value and carbon stock change modelling within the scope of sustainability reporting as requested in the Regulation (EU) 2020/852 (Taxonomy regulation).

According to the national regulation of Cabinet of ministers No. 675, **Silava** is responsible for the implementation of the national GHG inventory in LULUCF sector and development of GHG modelling framework, ensuring that the project findings and the upgraded model could be adopted in the national GHG inventory and for elaboration of the above mentioned reporting documents as soon as possible.

The results of the project will **directly affect forest owners**, primarily in Latvia, but also in the Baltic–c.a. 495 000 individual and legal persons in total. The results on the improved selection of genotypes, more tolerant to weather extremes, can readily be distributed via active tree breeding programs in all 3 countries, affecting more than 100 mil plants produced annually (most of them coniferous) – and thus the vitality of future forest stands. Moreover, the impact of the results will be extended to other land owners, since increased afforestation is planned in the Baltics as the principal mean to tackle climate change (and complies with the general EU policy goal of increased tree planting). Both the improved adaptability of the material, as well as updates in afforestation recommendations (project results) will boost the sustainability and multifunctionality of forests. Forest owner will also gain from the revised recommendation via increase tree vitality and reduced damages.

Substantial negative economic effect is associated with the current nature protection restrictions, although the estimates vary widely, depending on methodology. For some of the protection categories, as calculated in current LIFE+ project (June 2024), c.a. 70 mill. euro annual compensation of the forest owners is required (excluding the value-loss in wood processing chain and general economy). This figure is expected to increase in the future. Strict protection is essential in some cases, as implied in the Biodiversity strategy 2030. Current strategies and policies highlight the necessity to facilitate biodiversity in managed forests – hence major contribution to this aim, gained through combining intensive management and protection at forest landscape, to ensure wellbeing of all species, including humans. Project will provide new insides on efficiency of existing retention measures (and, potentially – how it can be improved), as well as data on species presence, diversity in stands with different combinations of management, thus helping to shape the understanding on the way protection can be implemented via adjustments in management practice.

Municipalities responsible for local territorial planning and in numerous cases also being forest owners, will gain from the developed recommendations and approaches to climate smart forest management with increased vitality of the stands in future. Since most of the recreation pressure is focused in peri-urban areas, development and implementation of the closer-to-nature forestry approaches, as well as improved understanding on more efficient forest regeneration (maintenance or renewal of forest view) can be applied in improved practice. Linked to recreation, most of the forest fire occur in peri-urban forests. Improved understanding on post-disturbance survival and growth of trees will help in local decision making after these events, and thus reduce the total negative impact.

During the project, an **interdisciplinary** groups of scientists from **LSIWC, Silava** and **LBTU** will be created. On the basis of knowledge from the interdisciplinary group, the processing of biomass from a diverse perspective will be possible, thus increasing the human capital potential and research capacity for the further development and testing of innovative bio-based products. In turn, the planned interdisciplinarity of the project (forestry, chemistry and materials science, etc.) and results will promote scientific collaboration of the scientific institutions with the industry, as well as will contribute to international recognition of scientific achievements.

There are several **indirect target groups of project**. The results of the project will make a significant contribution to the development of the industry, as the knowledge and experience generated will serve as a basis for companies in the wood processing industry (Letter of support from Latvian Forest Industry Federation) to develop alternative products. Small and medium-sized enterprises as well as large wood processing companies represented by Association "Latvijas koks (https://latvijaskoks.lv/) that deal with the processing of wood and forestry. In addition to basic products, the production residues will be transformed to value-added products. At the same time it will be a solution for improving efficiency, since currently the remaining residues mostly are burned, to produce heat. As a result, already existing traditional Latvian companies will be provided with a knowledge based and value-added recommendations that will promote the maintaining of human capital and the creation of new jobs. The results of the project will widen the horizons so that they can continue to make successful actions not only in Latvian companies but also in the wider region of Europe. They will have a significant economic impact in the regions, because there is a large share of wood processing enterprises. Such specific cross-sectoral projects will contribute to Latvia's economic growth. **Forest4LV** looks forward to develop technologies to a stage (TRL 5-6) where government and industry money can be used to complete development and potential commercialization. If by-products will be used simultaneously for the zero-waste production of bio-based polymers and wood-based composites, such a new processes will significantly reduce the initial costs of these products by improving the economic efficiency. The achieved results will enhance competitiveness in the existing market, as there already is interest and need for more environmentally friendly production processes, which is supported by both the raising of the public awareness about environmental problems, as well as the various environmental regulations, directives and guidelines of individual countries and at different levels of national associations.

2.5. Scientific results of the project and making them accessible

To increase the impact of the project, obtained results are intended to be published in the high-ranking scientific journals and disseminated through mass media by producing popular scientific content. The **Forest4LV** project dissemination strategy will make use of different communication and dissemination means, implementing targeted actions toward several target groups: the scientific community, industrial stakeholders, policymakers, public authorities, as well as media and the public at large (Table 1):

Table 1. Dissemination plan

Dissemination	Brief description	KPIs
Scientific papers (Scopus; WoSCC)	Holzforschung; J. of Renewable Materials; Polymers; Materials; J. for Cleaner Production; BioResources; New Forests; Silva Fennica, Baltic Forestr; Dendrochronologia; Wood Science and Technology, J. of Bioresources and bioproducts; J. of Functional Biomaterials; Industrial Crops and Products; European Polymer J.	31papers; 19 of them in Q1/Q2 journals;
Conferences	Int. Conf. on Renewable resources and Biorefineries (RRB), Int. Conf. on Bio-Based Polymers and Composite (BiPoCo), Int. Conf. Engineering for Rural Development; Achieving forest establishment at scale to address climate, environmental and economic challenges around the world (IUFRO); NordGen Forest Conference 2025; Ecosystem Services Partnership World Conference 2025; Conf. of the European Society for Biomaterials, MDPI online conference of Biomaterials, Wood Science and Engineering (WSE), Research for Rural Development	22 conference presentations
Data management	Research Data Management Plan (DMP) complying with FAIR principles will be developed at the beginning of the project (month 3). The establishment and maintenance of DMP and data sets will be realized in the specialized DMP platform ARGOS. Data sets will be published in Zenodo platform.	7 published data sets

Project web-site	On the LSIWC (www.kki.lv), **Silava** (www.silava.lv) and **LBTU** (www.lbtu.lv) websites information about the project will be published at the start (M1), and its progress reports will be published every 4 months.	5 published reports on each website
Social media	On the partners social networks (Facebook and Linkedin) will be published information about the project and its results	15 posts
Project closing conference	Informative project closing conference (parallel in-person and on-line) for stakeholders from government, industry and scientific community.	1 conference

3. Implementation

3.1. Applicant and scientific group

LSIWC has more than 70 years of experience in the field of wood research. The Institute has accumulated extensive knowledge and large experience in both applied and fundamental science and continues to acquire new knowledge and develop products and technologies related to wood, its components and bio-polymers. The comprehensive study of wood as a material and wood and bark biorefining, as well as bio-polymer composites are the main strategic research directions of **LSIWC**. **LSIWC**, during the international evaluation of the scientific institutions of Latvia performed in 2019/20, was awarded an overall score of 4, obtaining an assessment of 5 regarding social impact. Over the last 5 years, more than 40 projects have been successfully completed, about half of which aimed at creating new fundamental knowledge, while the rest are applied research, mostly in cooperation with entrepreneurs. **LSIWC** owns laboratory and administrative premises in Riga, and cutting-edge laboratory equipment for carrying out different tests, analysis and experiments. During the previous EU funding period, **LSIWC** focused on the development of their capacities to work at pilot scale level: TRL 4-6. The institute built a hangar for the pilot scale equipment and equipped it with pilot equipment for raw material preparation and also for various technological processes. The pilot scale hangar, which also functions as an Open Lab gives researchers and interested entrepreneurs the opportunity to develop fundamental research up to TRL 4-6.

Silava is the forest research centre of Latvia, with more than 50 years of experience and aim to ensure sound, data-drive support of forestry development. **Silava** carries out more than 100 research projects annually, ranging from small-scale, answering very specific single question, to participation in numerous forestry, bioeconomy, biodiversity focused Horizon project, as well as participation and leadership in international LIFE+ and INTERREG projects. During the international evaluation of the scientific institutions of Latvia, **Silava** performed similarly as **LSIWC**, receiving the highest score in effect of research (implementation in practice), thus complimenting the sphere of outstanding competence of **LSIWC**. Most of the research project of **Silava** involves partners either from private sector (forest management enterprises, forest owners, companies with interest in development of forest-related products), state organizations (e.g., Nature conservation agency) or NGOs – thus demonstrating the strong integration of our research in forest sector and capacity to distribute the results of **Forest4LV** project. **Silava** has good track record also in development of policy recommendations (as planned also in **Forest4LV**): we have established basis of sections on agriculture and forestry in Latvia’s national climate change adaptation plan 2030 and National climate and energy plan 2030 and its updates, as well as scientific basis and recommendations for actions, included in Forest and related sector development strategy for period 2015-2020 (approved by Cabinet of Ministers). **Silava** also fulfils the functions on protection and assessment of plant genetic resources, has developed and is leading Forest tree breeding program and National GHG inventory in LULUCF sector, as well as carries out NFI, including monitoring of numerous aspect of biodiversity: thus has most up-to-date knowledge and links to policies and practice in aspects relevant to identify and fill the knowledge gaps, identify relevant indicators and develop scenarios.

LBTU has over 70 years of experience in training specialists for the wood industry. It is currently the only higher education institution in Latvia that has prepared and continues to prepare Latvian woodworking engineers, masters and doctors in the programme of wood materials and technologies of the material science study direction. Without these specialists, the development of the Latvian wood industry, which supports the country's economy by producing and exporting significant quantities of wood panels and other bio-based wood products, is unthinkable. **LBTU** students acquire knowledge of the entire forest industry value chain, from forestry to wood processing. **LBTU** also implements engineering and environmental protection study programs. Research on innovative wood materials has been implemented in **LBTU** internal grants, including in cooperation with the Italian Institute of BioEconomy. This cooperation will be continued within this project, creating new knowledge and joint publications. The results of the project will expand students' knowledge about the possibilities of using pine and other tree species important for Latvia's growth in the creation and development of new products. Knowledge of the technical characteristics of innovative products and the environmental aspects of their practical use will provide a comprehensive understanding of the possibilities of their use in construction in accordance with the basic principles of the Sustainable Construction Memorandum.

As a result of the last scientific reforms in Latvia, each institution has become a recognized science center with concentrated human capital and infrastructure. All 3 institutions complement each other by working closely together. During the entire project implementation, the knowledges fulfilled by **Silava** and **LSIWC** will be forwarded to **LBTU** students as knowledge transfer.

3.2. Project activity plan

The duration of the ***Forest4LV*** project will be 16 months. The activities are structured in 5 WPs. The detailed content of each WP and methodologies are described below, including Milestones and Deliverables. The WP leader is indicated.

WP number/title	**1 – Forestry data**		
Implementation	M1 – M16	**WP leader**	Āris Jansons
Objectives:	Development of forest management practices, improving forest productivity and capacity to play a long-term role in climate change mitigation, enhancing the integration of biodiversity values and facilitating the production of a spectrum of forest ecosystem products and services in a changing environment.		

Description of content:

WP1 ensures data and results of analysis, necessary for modelling (WP2), material for testing and analysis (WP3) – therefore will work in close cooperation with these WPs to ensure on-time deliveries. Due to the call specifics, variety of results are expected from this WP (see table of sub-tasks). Therefore, leaders of each of the tasks and sub-tasks are specialized in their field (CVs attached), thus independent, parallel work will be carried out to ensure completion in very restricted time. Works will be carried out on the basis of existing research trials or set of defined sample plots, ensuring clear design and rapid start of implementation. Results of all tasks will be presented in scientific conferences practical (forest-sector and related) seminars and conference. Internal cooperation, will be boosted with regular (4 in total) seminars, presenting the progress achieved. To ensure growth of the competences, younger researcher and students will be involved in several subtasks. Materials to foster international cooperation will be prepared: RFFL (sites and plan), material for CSF network and for IEFC. To ensure continuity of research, two international project application will be prepared as well as finalization of 2 Ph.D. thesis facilitated.

T.1.1. Improved adaptation

Will be carried out in progeny trials as well as trials, where combined effect of regeneration methods, precommercial thinning intensity and application of ash, sludge can be evaluated. Assessment of genetic diversity (1.1.2) will be based on existing data (collected previously) with addition of 4 sites in the project. 4 manuscripts (including 2 in higher-ranking journals), combined with 2 presentations in conferences and 2 datasets.

T.1.2. Advanced forestry

All of the sub-tasks will conclude with manuscripts – 6 in total, except where technology and recommendations will be the main deliverable. Development of this accredited method will be based on capacity of Laboratory of forest environment in **Silav**a, and assessment of >1000 samples, collected during previous studies. Results will be distributed in 4 presentations in conferences.

T.1.3. Increased vitality

Assessments will be based on sites with known characteristics of disturbance (e.g. local maximum wind-speeds during the storm). Each of the assessed effects will be concluded in manuscript (4 in total), and scientific community introduced with results via presentations in 2 conference.

T.1.4. Enhanced biodiversity

Each of the sub-tasks will be concluded with manuscript and results presented in a relevant scientific conference

Table 2. Activities of the WP1

Management intervention	Method	Identified knowledge gap (to be solved)	Category of data	Notes of outcome
A.1.1.1. Regeneration	Planting	Genetically determined differences in reaction to weather extremes as modified by environment (forest type)	Growth, Adaptation	

A.1.1.2. Regeneration	Planting	Effect of reduced number of genotypes in propagation population on genetic diversity at the forest landscape scale	Biodiversity	
A.1.1.3. Regeneration × thinning	Planting	Interaction effect of plant material × soil scarification × regeneration method and thinning. Effect of initial application of green energy production by-products.	Survival, growth, quality, adaptation, bio-diversity	CSF, RFFL
A.1.2.1. Regeneration	Sowing, natural	Success of natural regeneration in challenging sites (peat soil) in comparison to sowing, and effect of sowing on genetic composition of stands	Biodiversity, survival, growth	CTN (D1.1)
A.1.2.2. Regeneration	Natural, planting/ shelterwood	Probability of regeneration success as influenced by shelter treatment	Survival, growth	CTN (D1.1)
A.1.2.3. Regeneration	Natural/ shelterwood	Tree related microhabitats on veteran trees	Biodiversity	CTN (D1.1) RFFL
A.1.2.4. and A.1.4.2. Retention	Retention of trees in shelterwood and clearcutting	Survival of retained trees after shelterwood harvest and retention trees in clear-cuts	Biodiversity	CTN (D1.1) (D1.4)
A.1.2.5. Afforestation	Planting	Species diversity, growth in different soil and hydrological conditions	Biodiversity, growth	(D1.2)
A.1.2.6. Thinning × genetics × application of green energy production by-products		Persistence of genetic gain after thinning with various intensity and site amelioration	Growth, adapt, biodiversity, quality	CSF RFFL
A.1.2.7.Thinning × stabilization of hydrological regime		Assessment of interaction affect in the conditions of Baltic artesian basin.	Survival, growth, quality	
A.1.2.8. Thinning × green energy production by-products		Development of technology for assessment of requirements of nutrients and prediction of stand response	Survival, growth, quality	D1.6.
A.1.3.1.Thinning, selective logging	Salvage logging (post wind, fire)	Effect of non-lethal wind and fire on growth	Adaptation, growth	(D1.3)
A.1.3.2. Thinning, selective logging	Salvage logging (insect × fungi)	Effect of *Ips acuminatus* in combination with wood inhibiting fungi on survival and increment	Survival, growth	(D1.3)
A.1.3.3. Regeneration	Planting, natural (admixture)	Effect of admixture and regeneration method on winter and summer browsing damages	Survival, growth	(D1.3)
A.1.4.1. Retention	Retention of trees in groups, wet patches	Efficiency of groups of retention trees and wet patches to preserve presence of *Odontoschisma denudatum*	Biodiversity	CTN (D1.1) RFFL (D1.4)
A.1.4.3. Thinning, selective logging	Removal of trees at different ages of stand	Quantitative assessment of changes of forestry effect: on deadwood, admixture and tree related microhabitats during a rotation cycle.	Biodiversity, survival, growth	RFFL (D1.4)

*CSF – climate smart forestry measure (policy recommendation, noted in WP5, M16); CTN – Closer-to-Nature forestry approach (policy recommendation, noted in WP5, M16); RFFL – Resilient Future Forestry Laboratory (sites and plan)

Milestones (Due month):

MS1.1 collection of all data, except vegetation, finalized (M7) MS1.2 delivery of data and calculations to WP2 finalized (M11)
Deliverables (Due month):
D1.1. Recommendations for more nature-friendly pine forest management techniques (M12); D1.2 Recommendations for the establishment of pine forest stands in areas to be reclaimed (afforestation) (M12); D1.3 Recommendations for increasing the vitality of pine forests (M12); D1.4 Recommendations for ensuring a favourable protection status for protected species in commercial pine forests (efficiency of applied measures based on model species) (M12); D1.5. Materials for Ph.D. course (1), RFFL (sites and plan), material for CSF network and IEFC prepared and datasets (2) ensured (M14) D1.6. Laboratory technology (method) accredited (1) (M16); D1.7. Applications to future projects (2), Ph.D. theses defended (2), manuscripts of planned publications submitted (M16)

WP number/title	**2 – Model, scenario analysis**		
Implementation	M1 – M16	**WP leader**	Kristaps Makovskis
Objectives:	Analysis and development of recommendations on the socio-economic aspects, including public benefits, for the development of multi-purpose forest management, new forest services, products and technologies.		
Description of content:			
The SMS development will be initiated by incorporating the effects of forest management on adaptation, growth, and tree vitality, identified in WP1 into the current yield modelling tool. To ensure holistic assessment of changes in forest management, the SMS will be supplemented with adjusted allometric calculation of principal ES (developed in WP2, one dataset) and biodiversity indicators (WP1). To ensure the accuracy and relevance of SMS for assessment of climate change mitigation effect of forest sector, substitution effect (from WP3) will be parametrized. Simultaneously, the body of literature will be reviewed to identify discrepancies in definition and assessment of the key performance indicators (KPIs) at different economic scale (e.g., company, national). The emphasis will be put on identification and classification of sustainable forest and land management (means and intensity) for sustaining biodiversity, productivity, regeneration capacity, vitality, and potential to fulfil relevant ecological, economic, and social functions. For social impact assessment, the necessary datasets will be acquired from open and closed sources (official and intrinsic reports). To aid the practical and political relevance of SMS, stakeholders (forest-related policy makers, NGOs, actors involved in green investing, etc.) will be engaged for defining the most plausible scenarios (to be modelled) via in-house workshops. Additionally, afforestation, identified as key factor in climate change mitigation policies (updated in June 2024), will be one of the key elements in workshops. These and further workshops will provide feedback on rolling results of SMS, aiding identification of potential additional aspects that needs to be tackled, and the main emphasis of necessary recommendations, thus implementing the agility principle. To assess the viability of modeled scenarios, their socioeconomic effects will be quantified and parametrized in SMS, including tradeoffs between assortment structures and HWP groups. It will be used for the estimation of the long-term socio-economic impacts of scenarios of restrictions on the management of commercial pine forests based on long-term projections and scientific data. Results will be presented in scientific conferences for publicity and publication (2). To increase the accuracy and informativity of sustainability reports of forest sector enterprises and KPIs within, methodological and scientific guidelines for presentation of information crucial to comply with requirements of Regulation 2020/852 and Directive 2022/2464, will be prepared. Results will be provided to interested parties as they become available and finalized for the project conference and reports. The methodological approach and results will also be included in materials for life-long learning and project application for its further development prepared.			
Milestones (Due month):			
MS2. Stakeholders' engagement workshop on scenario development (M8), key performance indicators (M10) and modeling results (M14)			
Deliverables (Due month):			
D2.1. Recommendations on the socio-economic aspects of forest management alternatives (M15) D2.2. Application of future project (1), in materials for life-long learning (1), dataset (1) manuscript of planned publications (2) submitted (M16)			

D2.3. Recommendations (guidelines) for policymakers and stakeholders on key performance indicators in sustainable forest management (M16)
D2.4. Recommendations (guidelines) for companies to evaluate KPIs for impact analysis and reporting on environmentally friendly production practices and environmental, social, and governance issues (M16)

WP number/title	**3 – Wood products and technologies**		
Implementation	M1 – M16	**WP leader**	**Janis Rizikovs**
Objectives:	Development of innovative technologies and products for using local forest resources to produce competitive and sustainable products, promoting the rational use of wood, developing wood construction in line with the Green Deal and contributing to the circular forest bio-economy.		
Description of content:			

To develop the innovative technologies and evaluate them to produce competitive and sustainable products using local forest resources and to promote the rational use of wood, two types of feedstock will be investigated in the **WP3** on the basis of the most common wood species in Latvia - pine and birch (in some tasks also alder and aspen): 1) Residues form sawing of pine timber and/or WCM production – sawdust (50%) and bark (10-20%); 2) Residues from birch plywood production – veneer chips (up to 40%), veneer peeler core (6%) and bark (10-20%). All of the Tasks were set as defined in regulation of the call.

Task 3.1 The technologies and products to expand the use of wood-based materials in construction in line with the EGD (M1-16) Leader Bruno Andersons

To achieve objectives of the **T.3.1.** the evaluation of juvenile wood (JW) in glued wood products, as well as thermo-modification (TM) of veneers to improve the plywood weathering properties will be investigated. Activity **A.3.1.1.** aims to investigate the JW of pine (*Pinus sylvestris* L.) and birch (*Betula* spp.) focusing on the technological possibilities of its use. Wood samples will be obtained from the forest thinning (in cooperation with **Silava**) and the plywood industry as veneer peeling cores. In the project, JW parameters will be analyzed which can affect the JW interaction with adhesives and glued product application: anatomical characteristics, chemical composition (incl. extractives), physical and strength properties (interaction with moisture and water, buffer capacity, bio-durability, etc.). Given the limited duration of the project, a feasibility study will be carried out regarding the gluing of JW, clarifying the characteristics of the glued products, the suitable types of glues, and the output technological data. Preliminary data will be obtained for the development of life cycle assessment (LCA) of JW products in the course of future projects.

Several wood TM methods will be evaluated to obtain plywood from veneers modified in nitrogen and vacuum atmosphere. TM of birch (*Betula pendula*) and pine (*Pinus sylvestris*) wood in a closed process under pressure in nitrogen have been initially studied at **LSIWC** for the last 2 years. Therefore, the impact of TM on the aspen (*Populus tremula*) and black alder (*Alnus glutinosa*) wood physical and mechanical properties, biological durability and weathering performance will be evaluated in the **A.3.1.2**. While **LBTU** in **A.3.1.3.** will use birch (*Betula pendula* Roth.), aspen (*Populus tremula* L.) and poplar (*Populus x canadensis* Moench.) veneers obtained by vacuum TM in cooperation with project scientific institution partner - Italian Institute of BioEconomy (IBE). Bio-adhesive – birch bark processing product suberinic acid will be used to bond the thermo-modified veneers (**A.3.2.3.**). The plywood gluing parameters will be clarified (adhesive consumption, pressing time etc.). The gluing quality, strength and other properties of the obtained plywood will be tested. In order to compare the environmental impact of the obtained plywood during the entire product life cycle with traditional birch plywood, a LCA is planned.

Task 3.2 Biorefining technologies for the integrated use of forest resources to produce higher value-added products (M1-16) Leader Maris Lauberts

To integrate forestry and wood processing residues as a feedstock in sustainable biorefining technologies to obtain high added value products several feedstock and target products will be investigated. All types of woody by-products will be covered: 1) hardwood forestry or plywood residues (birch as reference material); 2) bark of common wood species (pine); 3) pine wood sawdust after sawing of timber and/or from CWM production residues, which make up about 46% of the log. In **A.3.2.1.** the catalytic pretreatment technology of plywood residues will be carried out to obtain **5-hydroxymethylfurfural (5-HMF)**. The proposed solution involves two stages: 1) birch wood catalytic hydrothermal pretreatment to selectively separate the hemicellulose portion and convert it into furfural (a product imported into the EU), thereby gaining better access to the cellulose part for its transformation into 5-HMF; 2) catalytic treatment of the lignocellulosic residue in the organic solvent environment. By integrating these two processes, the opportunity arises to utilize 60-70% of the birch wood processing byproduct stream in the plywood production plant. In **A.3.2.2.**

processing of birch and pine barks into **catechol-moiety bearing extractives** will be carried out. Hot solvent extraction of alder, birch, and pine bark, obtained from Silava (**WP1**), will be performed using glycerol or glycerol-water mixtures. The extraction conditions (solid/liquid ratio, temperature, pressure, number of extraction cycles, etc.) will be optimized using response surface modeling. Catechol-moiety-bearing compounds will be absorbed onto appropriate resins, such as Amberlite XAD-2 for oregonin, and then desorbed using a glycerol-water mixture as the solvent to obtain the final product. In both cases, water will be eliminated to achieve at least 70% glycerol content. The composition of the obtained extracts will be studied using liquid and gas chromatography analyses, FTIR spectroscopy, and UV/VIS spectrophotometry analyses. The DPPH$^{\bullet}$ radical scavenging activity of glycerol extracts will be measured, and low values of IC_{50} will be considered as indicators for further testing in skin-care formulations. The antimicrobial activity of extractives and wound dressing films incorporated with bark glycerol extracts will be tested using broth dilution assay and direct contact assay.

In **A.3.2.3.** pine wood sawdust (filler) and ecological binder (from birch bark) will be used to obtain **ecological wood-based composites**. Replacing synthetic binders with ecological ones from birch bark will solve several problems affecting both human health, environmental pollution, and utilization aspects. By adapting the developed ecological binder to individual wood species, including pine wood, several technological aspects will be tested (pressing temperature, duration, binder amount, physical-mechanical properties of the boards). This will increase the flexibility of the developed technology, its TRL and competitiveness, moving towards the transfer of the technology at the industrial level. Developed new particleboard product will be compared with similar products on the market by testing its physical-mechanical properties according to current standards and evaluating their suitability for furniture constructions. Also, this material will be tested in combination with wood cellular material from **A.3.5.1**, wood polymer composites from **A.3.4.3.**, as well as plywood from thermo-modified veneers from **A.3.1.2.** and **A.3.1.3**.

Task 3.3 Use of wood processing and wood biorefinery residues for the production of polymer composites and insulation materials (M1-16) Leader Aiga Ivdre

To solve the problems of using wood processing residues to obtain bio-based polymer composites and insulation materials, several biomass processing by-products were chosen as a feedstock - bark extraction residue from **A.3.2.2.**, wood mechanical processing residues, as well as pulp production residue from pine wood (tall oil). These residues will be investigated to obtain several polymer products for insulation (**bio-based rigid PU foams**) and for increasingly popular interior materials (**wood polymer composites - WPC**) to increase their added value and substitute the petrochemical part with biobased compounds. The aim of **A.3.3.1**. is to leverage the benefits of both suberinic acid-based polyols and tall oil-based polyols to develop rigid polyurethane (PUR) foams with enhanced thermal stability and reduced flammability (TRL 6). To achieve this, suberin depolymerization technology will be adjusted to produce three different suberinic acids (SA) with various polyphenol contents (ethanol alkaline solution, temperature, acidification pH). Respective SA-based polyols will be synthesized. Tall oil-based polyols will be used to lower the viscosity of the polyol systems. Additionally, more sustainable alternatives to Tris chloroisopropyl phosphate (TCPP), e.g. ammonium polyphosphate, triethyl phosphate, and graphite, will be explored for the PUR foam formulation to reach appropriate flammability properties. This approach aims to develop PUR foams that not only reach flammability requirements but also are more environmentally friendly and safer for human health.

In **A.3.3.2** methods for isolating carbohydrate-enriched fractions from extracted pine bark (**A.3.2.2**.) through hydrothermal treatment using a high-pressure PARR reactor will be developed. The component and functional compositions of the extractives will be studied using GC, HPLC, and wet chemistry methods. Oxypropylation will be performed at 150-170°C and ambient pressure, with FTIR spectroscopy used to monitor the reaction. GPC and wet chemistry methods will characterize the obtained polyols, which will be introduced into PUR foam recipes as substitutes of commercial fossil-derived polyol polyethers. The remaining bark fraction will be used as a filler in the PU foam composition. The compression characteristics, dimensional and thermal stability, closed cell content, and thermal conductivity of the PUR foams with a high content of renewables will be studied.

In **A.3.3.3.** targeted and scientifically-based improved physicochemical functionalization of pine wood residue (**T.3.5.**) will be tested to control the compatibility and regulate the interaction between the pine filler and polymer matrix in the wood polymer composite (WPC), intended for production of WPC for building interior design. The WPC will be made from recycled polypropylene as a polymer matrix and functionalized pine sawdust with the addition of biological additives obtained from wood biorefining. The WPC processing parameters (processing temperature and time, screw velocity, torque, injection molding pressure) will be determined and the properties of the WPC (mechanical, including impact viscosity, dimensional stability, wettability, thermostability) will be investigated. The final formulation of the WPC will be selected, characterized by its mechanical properties, hydrophobicity and thermostability will characterized and product will be evaluated to respond to the Circular economy requirements **approved by LBTU (T.3.5.).**

Task 3.4 Original solutions for innovative products based on logging by-products and non-wood materials (M1-16) Leader Laura Andze

In the task there will be investigated two completely different research fields using different wood processing residues (birch veneer peeling core and pine wood residues from **T.3.5.**). In **A.3.4.1.** densification of chemically pretreated wood into the osteosynthesis implant material (medicine) will be investigated. Improvement of the birch wood (veneer peeling core) properties, increase biocompatibility and reduce swelling will be implemented by the sequential 4-step treatment method - partial delignification using the soda process, followed by extraction, chitosan-impregnation and thermal densification of the solid wood. Biomechanics and implant stability in bone will be studied in a specially designed test facility already owned by **LSIWC**. As a result, new product prototype and technology will be developed. In **A.3.4.2.** the *P. gigantea* spore production on pine residues (from **T.3.5.**) will be investigated to be used in forestry practices to reduce root and butt rot caused by the fungus *Heterobasidion* in coniferous stands in **WP1**. In 2023, **LSIWC** and **Silava** signed a License agreement (agreement no. 2023/56e-IP/LIC) for intellectual property "Biologic preparation for stem protection against *Heterobasidion* spp. spore infection and isolate suspension mixture obtainment method" use, envisioning rights for *Phlebiopsis gigantea* isolate PG 182 un PG 382 production up-scale research. As a result *P. gigantea* biological control agent pilot batch of 50 L will be produced and technology description developed.

Task 3.5 Increasing the efficiency and accuracy of the use of wood resources, smart technology solutions (M1-16) Leader Uldis Spulle

Cellular wood material (CWM) and Lightweight Stabilized Blockboard (LSB) have a lack of detailed and comprehensive information about the properties for potential manufacturers to create a declaration of product conformity. Part of the clarification of these characteristics is planned to be carried out in this task.
In **A.3.5.1.** the CWM will be manufactured according to the standard requirements and selected properties of CWM and structural element will be tested (incl. physical-mechanical characteristics, acoustic properties, combination of smart technology materials).
In **A.3.5.2.** the LSB building elements (doors, walls etc.) will be calculated in order to carry out its successful implementation. Smart technology parameters (cutting speed, resistance, energy consumption etc.) will be approved and the technological and operational characteristics of LSB will be determined (dimensional stability (i.e., shrinking-swelling), etc.). CWM and LSB materials will be tested in combination with ecological particle boards from **A.3.2.3.**, WPC from **A.3.4.3.**, as well as plywood from thermomodified veneers from **A.3.1.2.** and **A.3.1.3** and will be evaluated to respond to the Circular economy requirements **approved by LBTU**. In addition, the residues from the production of the CWM will be used as feedstock in **A.3.2.3.**, **A.3.3.3.** and **A.3.4.2.** to evaluate the increase of the added value.

Milestones (Due month):

MS3.1. Selected best feedstock for further development of new products and technologies (M10)
MS3.2. Collected key performance indicators for data sets and recommendations (M14)

Deliverables (Due month):

D3.1. 8 New product protypes (M16) - *A.3.2.2., A.3.2.3., A.3.3.1., A.3.3.2., A.3.3.3., A.3.4.1., A.3.4.2., A.3.5.1.*;
D3.2. 5 New technology descriptions (M16) - *A.3.1.2.; A.3.2.1., A.3.2.2., A.3.4.1., A.3.4.2*.;
D3.3. Recommendations on the usage of wood-based materials in furniture and construction elements (M16);
D.3.4. Recommendations on the usage of wood processing residues to produce added value biobased materials (M16);
D.3.5. 4 data sets for WP2 Model, scenario analysis (M16);
D3.6. 12 scientific articles at Q1/Q2 scientific journals (M16).

WP number:	**4 – Coordination and management**		
Implementation	M1– M16	**WP leader**	**Ugis Cabulis**
Objectives:	To ensure an adequate management of the project by ensuring the scientific, financial and administrative coordination, to establish an internal communication platform, and a Data Management Pan, leading to high-quality project results.		
Description of content:			
T4.1 Scientific and financial management and coordination (M1-M16).			

LSIWC as Project Coordinator (PC) will be responsible for scientific coordination and ensuring the implementation of the Agreement with Latvian Science Council (LSC), monitoring and coordinating project work and the submission of deliverables and reports. WP leaders are responsible for activity planning and implementation within their WPs. Practicalities of consortium and project operation along with necessary templates will be provided in the **Project Management and Quality Plan** (M2). **T4.2 Data Management (M1-16)** Research Data Management Plan (DMP) will be developed **no later than 3 months after the start** of the implementation of the project and will comply with FAIR principles. DMP will be created in ARGOS platform (https://devel.opendmp.eu/splash/index.html) and published in Zenodo platform (https://zenodo.org/). Data will be organized and linked to respective WPs. **T4.3 Administrative matters and ethics (M1-M16)** The successful execution of all administrative matters and compliance with ethics regulations will be ensured. **LSIWC** will facilitate communication within the consortium on administrative matters, prepare and transfer any project-related administrative documents required by the LSC or relevant ministry. Ethics regulations will be continuously monitored to maintain a discrimination-free project operation.
Milestones (Due month):
MS4. Project management and quality and Data management plans (M3)
Deliverables (Due month):
D4.1 Project management and quality plan (M2); D4.2 Research Data Management Plan established (M3) and finalized (M16).

WP number:	**5 - Exploitation and dissemination**		
Implementation	M1– M16	**WP leader**	**Ugis Cabulis**
Objectives:	▪ To disseminate project results		
Description of content:			
The dissemination activity will be organized to reach results according to the Projects results table and to disseminate non-confidential information about the project and its results to as broad an audience as possible. **T.5.1** The knowledge and insights accumulated in the WP1-3 will be the basis for the development of recommendations for the state and public sector, as well as industry. Throughout the development of the program, consultations will take place with all stakeholders interested in the results, thus ensuring that they will receive the necessary recommendations for the further development of the industry. **T.5.2** Results from tasks in WP1-3 will be used to prepare scientific publications and presentations in conferences. The topic of the scientific paper is mentioned in the respective WP. The results of the **Forest4LV** will be presented to the wider public, including the government, industry and scientific community, at the closing conference of the project (possibly together with another State Research Program).			
Milestones (Due month):			
MS5. Initiation of dissemination and exploitation activities (M12)			
Deliverables (Due month):			
D5.1 Climate smart and closer-to-nature forestry recommendations developed and delivered to national and international policy makers (due date reported in respective WP); D5.2 Publication of at least 21 original scientific articles; (due date reported in respective WP); D5.3 Participation in at least 12 international scientific conferences (due date reported in respective WP) (M16); D5.4 A dedicated section on the all partners websites will be contributed to the ***Forest4LV*** project and updated every 4 months (M1, M4, M8, M12, M16); D5.5 Organization of **Forest4LV** closing conference (M16).			

Table 3. List of deliverables

WP	Task	Articles Q1/Q2	Other articles	Conferences	Product prototype	Technology prototype	Recommendations for policy makers	Recommendations (other)	Data sets	Dr. thesis	Other*

WP1	T.1.1	2	2	2			2	2	2	2	6
	T.1.2	2	4	4		1					
	T.1.3	2	2	2							
	T.1.4	1	1	1							
WP2			2	2			2	1	1		5
WP3	T.3.1	3		2		1		1	1	1	23
	T.3.2	3		3	2	2			1		
	T.3.3	3		3	3				1		
	T.3.4	2		1	2	2			1		
	T.3.5	1	1	1	1			1		1	
WP4				1							2
WP5							2				>31
Total		**19**	**12**	**22**	**8**	**6**	**6**	**5**	**7**	**4**	**>67**

*Other results in WPs:
WP1 – Project proposal in national/international calls (2 pcs.); material for sudy courses in university/ies (1 pcs.); material for CSF network and IEFC (3 pcs.).
WP2– Project proposal in national/international calls (1 pcs.); material for sudy courses in university/ies (1 pcs.); stakeholders' engagement workshop (3pcs.).
WP3 – Project proposal in national/international calls (23 pcs.).
WP4 - Project management and quality plan (1 pcs.); Research Data Management Plan (1 pcs.).
WP5 – Project closing conference; project update in partners' hompages and social networks (>30 pcs.)

3.3. Project management and risk plan

Project management (WP4) will be coordinated by **Forest4LV** leading partner **LSIWC** and project management team led by experienced manager, scientific director of **LSIWC** Ugis Cabulis (h=30) will conduct a critical assessment of the existing human resources in terms of their expertise, skills and knowledge value and map the missing competences (e.g., management, research, technology transfer, project proposal writing, PR, etc.). WPs leaders Aris Jansons (h=24), Janis Rizikovs (h=14), Kristaps Makovskis (h=8) will be responsible for the work coordination and deliverables of each WP.

Project management team from all 3 partners will be provided by administrative and scientific staff having its own competence and responsibility. The Project Administrative Staff will monitor execution of administrative affairs of the project, including the management of resources, while the Project leader will monitor an execution of the scientific research of the project and preparation of the periodic reports.

The management will be realized in line with the Latvian legislation and international legislation. The common administrative capacities of ***all 3 partners*** will be utilized to support the realization of the management and preparing the reports of the project. Within the framework of the project, a separate accounting of the costs of the project will be carried out, a separate bookkeeping records will be introduced, and all invoices received within the framework of the project will be accordingly endorsed and recorded. In all the project-related documents, the project ID number will be indicated. The Procurement departments will be responsible for carrying out procurement procedures according to the Latvian Public Procurement Law. The administration of ***all 3 partners*** will realize other administrative duties (such as regulation of labour relations) predicted by the Latvian legislation as the sphere of the competence of institutions as a legal entities.

Project risk assessment is shown in **Table 4**. As the greatest risk for the EU chemical industry, including PU industry that must be taken into account is raw materials confirmation with REACH. All potential raw materials at the first will be evaluated from the point of view of REACH, and the as the supplier of material from EU will be preferred. Especially it is important for PU system catalysts, because the more effective catalysts are tin containing catalysts, historically used in PU technology, but now, they could be replaced by reactive amine catalysts with similar effectiveness.

Table 4. Project risk assessment

Risk assessment					
No.	**Risk**	**Risk description**	**Assessment**		**Risk prevention/mitigation measures**
			Probability	**Impact**	

1	Strategic	Inconsistency of the project topic with the regulations and strategy of the institute, as well as the project topic, which is not relevant to the industry needs	Low	Medium	The topic of the project is approved by the director and the Scientific Board of the **LSIWC** before project submission, therefore the risk is minimized. **LSIWC** has wide cooperation experience with the leading industry companies and has met the needs and possibilities of industry. Both partners' research field corresponds to the aim of the project call, and participation is approved by the director and dean of **Silava** and **LBTU**, respectively.
2	Operational	Incomplete planning of scientific activities	Medium	Medium	The monitoring of scientific activity planning and implementation will be ensured by the project scientific leader, who has relevant experience in research/project management and execution. A responsible person for each WP and task is designated, to share responsibility in a "bottom-up" approach. The project scientific group participated in the definition and planning of the above-mentioned activities, so that those would be clear, proportionate to the planned timetable and ensure the achievement of the planned results.
3	Implementati on	Risk of the occurrence of unforeseen complications	Low	Medium	Project team has an extensive experience in research project implementation, therefore the nominated tasks have been selected carefully after a thorough analysis of the scientific capacity of the project implementers and aim and tasks of the project call. During the project planning, several alternative scenarios and research methods and approaches are already identified.
4	Result achievement	Risk of undelivered results	Low	Medium	Project team has carefully analyzed the scope of the project, regulation of the project call and other related documents, project implementation time and available resources to nominate an appropriate amount of the deliverables. Project scientific and MP's managers will closely monitor the implementation progress and will offer solutions or change of research course in order to achieve the aim of the project and to deliver all results.
5	Financial	Risk of inadequate expenditures	Low	High	To reduce the risk occurrence probability, it is planned to attract a qualified project manager. This risk occurrence probability is minimized by preparing a detailed project budget already before the submission of the project, by carrying out the cost planning and checking whether the costs comply with the eligible costs set out in the CM regulations.
6	Legal	Changes in legislation	Low	Low	During the project development, the project implementation is planned in accordance with the existing legislative requirements, while changes forecasting in normative acts is beyond the project partners' control. During the project implementation, the project management team shall carry out monitoring of the changes in normative acts and, where necessary, shall carry out the appropriate changes, coordinating those with the project financier.
7	Human resources	Insufficient human resources	Medium	Medium	Scientists, whose current experience, quality and motivation of the work reduce the risk of the turnover of the personnel important for the project, will be involved in the project. If any of the originally planned staff members is not be able to participate in the project, an equivalent qualification specialist will be involved in due time (already during the project development, equivalent qualification specialists are identified, if there is a need for the attraction of another specialist).
8	Technological	Insufficient equipment availability	Medium	Low	The equipment necessary for realizing the project applicant's activities and gaining the results is mastered and available for the project participants. The technological process is explained and understandable for the scientific personnel. All RO has extensive facilities and modern equipped laboratories. Which are significantly extended. The staff is very well trained to work with the equipment. All partners have the necessary logistical support, including premises and equipment.

LATVIJAS MEŽA ĪPAŠNIEKU BIEDRĪBA

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Letter of Support for the State Research Program "Forest4LV"

Innovation in Forest Management and Value Chain for Latvia's Growth: New Forest Services, Products and Technologies

4th of July, 2024, Riga

To Whom It May Concern,

I am writing on behalf of **Latvian Forest Owners' Association** to express our strong support for the **Forast4LV** proposal submitted to the State Research Program call. As Chairman of the Board of Latvian Forest Owners' Association, I would like to emphasize the importance of the planned Program's objectives and its potential impact on enhancing bioeconomy development and circularity assessment capacity in Latvia and in the Baltic region.

Latvian Forest Owners' Association is an umbrella organization for private forest owners in Latvia, representing our country in the Confederation of European Forest Owners (CEPF), International Family Forestry Alliance (IFFA) and European Landowners` Organization (ELO), as well as ensuring information and policy support for our members to safeguard sustainable, multiple-use forestry in Latvia. Our organisation recognizes the critical need to address sustainability challenges and promote bioeconomy and circular economy practices. The goals outlined in the Forest4LV proposal align with our own mission and objectives, making this Program a compelling opportunity for collaboration and positive change. By leveraging the collective expertise of industry, academia, government, and civil society stakeholders, this Program holds the potential to drive innovation, foster best practices, and elevate the sustainability profile of Latvia.

Latvian Forest Owners' Association are enthusiastic about the prospect of collaborating with the Forest4LV consortium to collectively advance the objectives outlined in the Program.

Yours sincerely,

....

Arnis Muižnieks,
Chairman of the Board
Latvian Forest Owners' Association
info@mezaipasnieki.lv

AKCIJU SABIEDRĪBA ”LATVIJAS VALSTS MEŽI”
Vienotais reģistrācijas Nr.40003466281
Vaiņodes iela 1, Rīga, LV-1004, Latvija
tālrunis 67610015, e-pasts: lvm@lvm.lv

Riga
PLEASE, SEE THE DATE OF THE DOCUMENT WITHIN SIGNATURE OF TIME STAMP OF THE DOCUMENT
PLEASE, SEE THE REGISTRATION NUMBER IN THE DOCUMENT ATTACHMENT

Latvijas Valsts mežzinātnes institūts “Silava”
Rīgas iela 111, Salaspils, Salaspils novads, LV-2169
and to
The evaluation commission of applications to the National Research Programme ‘Research and Sustainable Use of Local Resources for the Development of Latvia 2023-2025’

Letter of Support for the Proposal ‘Forest4LV’

Innovation in Forest Management and Value Chain for Latvia's Growth: New Forest Services, Products and Technologies

JSC Latvia’s State Forests (in Latvian – AS “Latvijas valsts meži”) expressing strong support for the Forast4LV proposal submitted to the National Research Programme call (hereinafter – the Programme). We would like to emphasize the importance of the Programme’s objectives and its potential impact on enhancing bioeconomy development and circularity assessment capacity in Latvia and in Baltic region.

The core activity of JSC Latvia’s State Forests is state owned forest management, ensuring multiple benefits for the society. Our organisation recognizes the critical need to address sustainability challenges, promote bioeconomy and circular economy practices. The goals outlined in the Forest4LV proposal align with our own mission and objectives, making this for compelling opportunity for collaboration and positive change. By leveraging the collective expertise of industry, academia, government, and civil society stakeholders, proposal Forest4LV holds the potential to drive innovation, foster best practices, and elevate the sustainability profile of Latvia.

JSC Latvia’s State Forests are enthusiastic about the prospect of collaborating with the Forest4LV consortium to collectively advance the objectives outlined in the Programme.

Signature not validated

Board Member Māris Kuzmins

Digitally signed by MĀRIS KUZMINS
Date: 2024.07.08 11:34:19 EEST

THIS DOCUMENT HAS BEEN SIGNED WITH SECURE ELECTRONIC SIGNATURE AND CONTAINS TIME STAMP

Jānis Gercāns
67610015
j.gercans@lvm.lv

Latvijas
KOKRŪPNIECĪBAS
federācija

Riga, 205.07.2024
Nr.1-07/2024

Letter of Support for the State Research Program "Forest4LV"

Innovation in Forest Management and Value Chain for Latvia's Growth: New Forest Services, Products and Technologies

To Whom It May Concern,

I am writing on behalf of **Latvian Forest Industry Federation** to express our strong support for the **Forest4LV** proposal submitted to the State Research Program call. As member of the board and CEO at **Latvian Forest Industry Federation**, I would like to emphasize the importance of the planned Programm's objectives and its potential impact on enhancing bioeconomy development and circularity assessment capacity in Latvia and also in Baltic region.

The core activity of **Latvian Forest Industry Federation** is to represent the interests of companies, that are involved in forestry activities and wood products manufacturing industry. Our organisation recognizes the critical need to address sustainability challenges and promote bioeconomy and circular economy practices. The goals outlined in the **Forest4LV** proposal align with our own mission and objectives, making this Program a compelling opportunity for collaboration and positive change. By leveraging the collective expertise of industry, academia, government, and civil society stakeholders, this Program holds the potential to drive innovation, foster best practices, and elevate the sustainability profile of Latvia.

Latvian Forest Industry Federation is enthusiastic about the prospect of collaborating with the **Forest4LV** consortium to collectively advance the objectives outlined in the Programm.

Yours sincerely,

....

Artūrs Bukonts
Member of the board, CEO
Latvian Forest Industry Federation

This document is digitally signed